HUGO GERNSBACK, Editor

RADIO CRAFT

RADIO-ELECTRONICS

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SEPT 1948

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RADIO — ELECTRONICS

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Before the war when there was no lead shortage, Bell Laboratories engineers sought to develop better and cheaper cable sheaths. An ideal sheath is strong, flexible, moisture-proof, durable and must meet specific electrical requirements. No single material had all those virtues, so thoughts turned to a composite sheath, each element of which should make a specific contribution to the whole.

Various materials and combinations were studied. Desirable combinations that satisfactorily met the laboratory tests were made up in experimental lengths, and spent the war years hung on pole lines and buried in the ground. After the war, with an unparalleled demand for cable and with lead in short supply, selection was made of a strong composite sheath of *AL*uminum and *PolyETH*ylene. Now Western Electric is meeting a part of the Bell System's needs with "*ALPETH*" sheathed cable.

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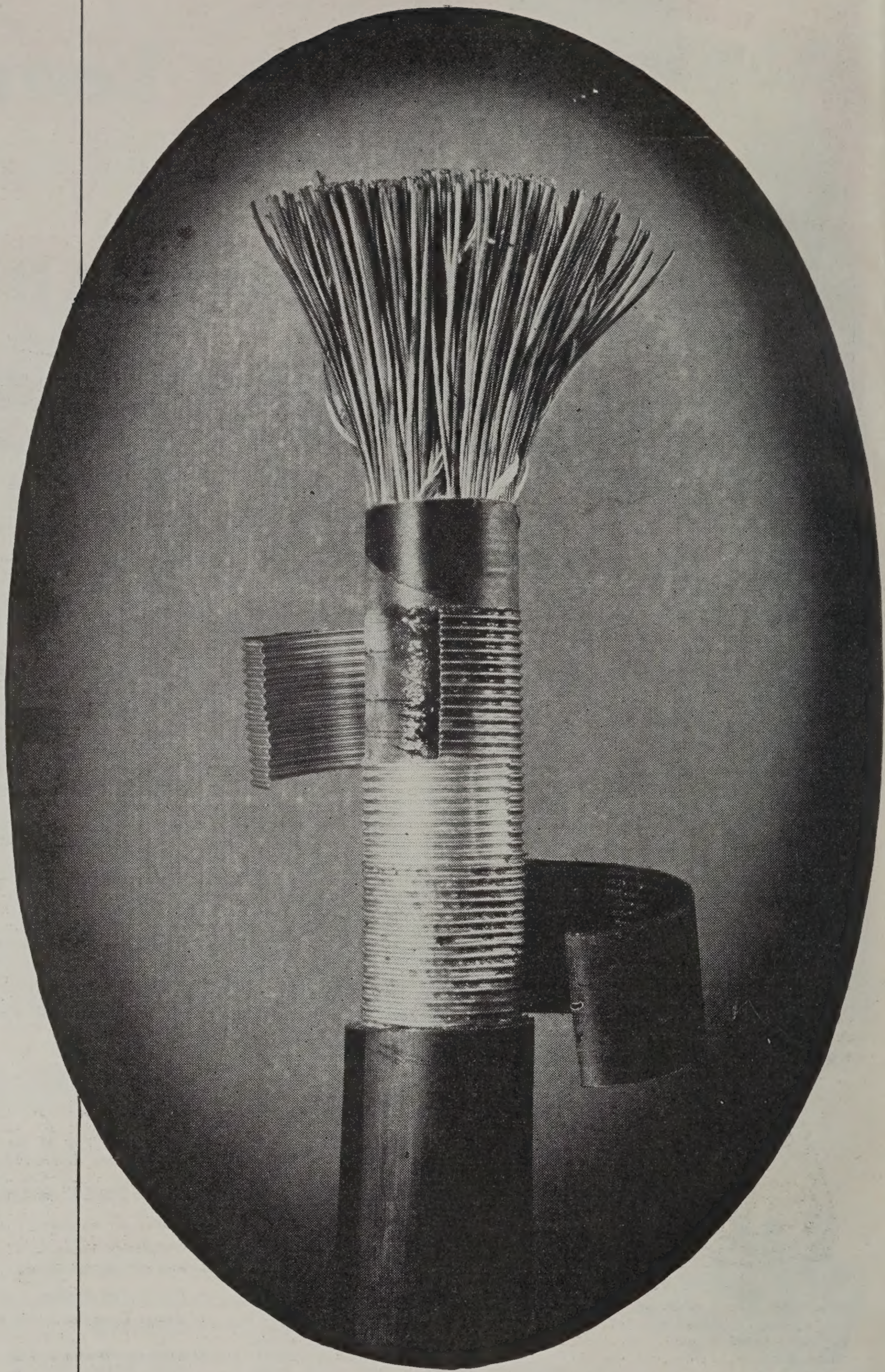

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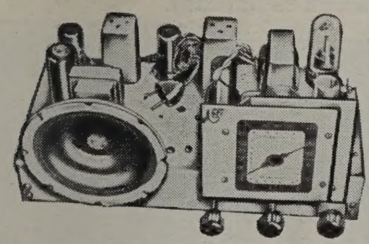
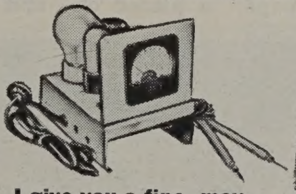
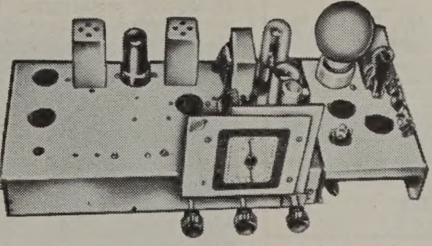


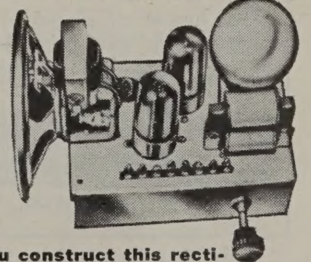
You really learn Radio the PRACTICAL way . . . when you build this big, powerful 6-tube Superhet Radio from parts I send you.



I give you a fine, moving coil type Meter—with parts for a complete analyzer and Circuit Continuity Tester. "Trouble-shoot" with professional accuracy.



You don't have to buy expensive ready-made equipment. You get valuable experience building this Signal Generator and Multi-purpose Tester.



You construct this rectifier and filter, resistor and condenser tester, and really get on the Practical end of Radio.

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TELEVISION TECHNIQUES were used last month by Northwestern University to instruct doctors and medical students in operative methods. The broadcasts, described by the university as the largest medical classroom in the world, had an estimated audience of 7,000.

Four image orthicons were set up in the Passavant Memorial Hospital in Chicago, two above each of the two operating tables. Every detail of the operations was clearly picked up and reproduced on the screens of receivers on the Navy Pier and throughout the campus in classrooms. John K. West of RCA, which made the technical arrangements, said the setup was the largest temporary TV installation ever made.

During the operations, the surgeon in charge commented on each of the steps he took. Before the operations, he lectured on the case history.

The television technique has the same effect as the instructional operating theatre but it gives each student a much closer view and enables an almost infinite number of observers to watch at the same time.

A FACSIMILE machine designed to increase the speed of telegraph service was announced last month by Western Union. The machine, 10 x 11 x 7 inches, will be installed first in the offices of customers who handle five to twenty messages per day.

The sender of a message writes his text in longhand or by typewriter on a sheet of sensitized paper. The message is placed on a roller, in contact with which is a stylus. As the roller turns, current through the paper varies according to the written or typed marks.

The machine automatically becomes a receiver when the central office signals that a message is on hand. A blank sheet of sensitized paper is placed on the roller and the stylus, transmitting current through the paper, causes the transmitted writing to appear.

The machine, developed less than a year ago by Garvice H. Ridings, is expected to cut time required for message transmission between New York and San Francisco to 10 minutes.

ULTRASONIC diagnosis and treatment of cancer was demonstrated last month by Drs. J. F. Herrick and E. J. Blades of the Mayo Foundation Institute of Experimental Medicine.

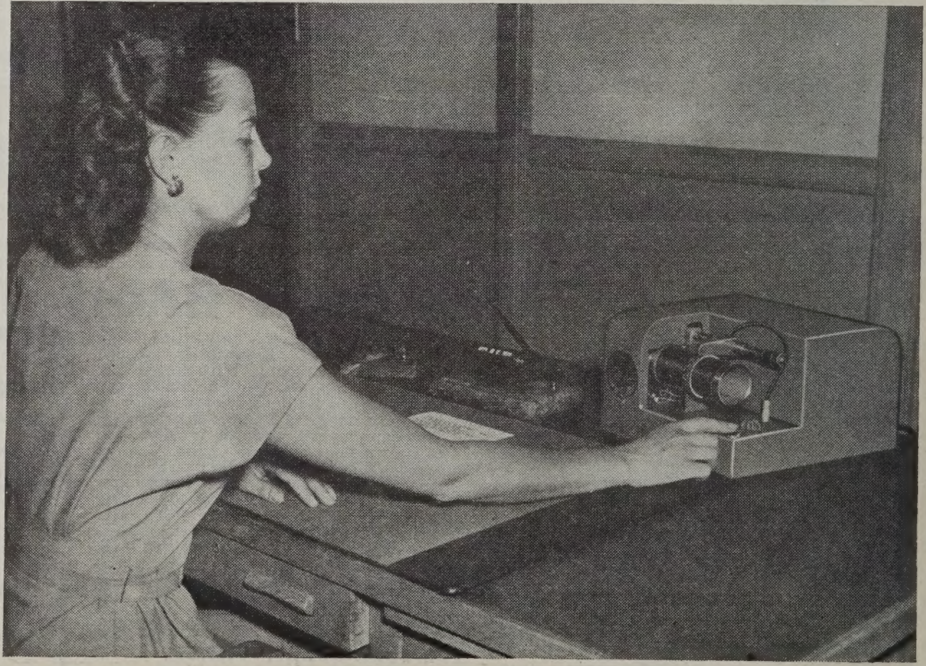
Supersonics, generated by crystals and transmitted to the body through paths of oil or water, travel in a sharply focused beam. The beam is reflected by any part of the body it hits, and where there is a cancer the character of the reflection or echo is abnormal.

After the cancer is detected it may be treated by the same type of ultrasonic beam, though with increased intensity. The beam, directed against the cancer, shakes it to pieces, destroying the tissues cell by cell.

The Mayo experiments have so far been only on animals. Other types of knifeless surgery using ultrasonics are also under investigation.

MINIMUM WAGES for radio technicians are established in a new order passed by the government of the Canadian province of British Columbia. The order, which went into effect June 1, defines the qualifications and the work of a radio technician and raises his minimum pay from the unskilled-labor rate of 54 cents per hour to 80 cents. The order also regulates the number of working hours and overtime pay.

The order was promulgated as a result of the work of the Associated Radio Technicians of British Columbia, an organization of radio repair, installation, and design technicians.



New Western Union facsimile machine brings the telegraph office to the executive's desk.

SPECIAL PERMITS for AM broadcast stations to operate beyond their regular daily sign-off times were abolished by the FCC last month. Limited-time stations have been applying for and receiving these "special temporary authorizations" for several years to permit them to broadcast programs which would not fit into their limited schedules.

The authorizations defeated the purpose for which the stations' broadcast time was limited—to prevent nighttime interference with others on the same frequency. The situation is particularly bad now that the number of AM stations on the air is so great.

THE IRON LUNG may be replaced by a new electronic instrument which was shown last month at the first international poliomyelitis conference in New York. The instrument, called an electronic stimulator, operates on batteries and is small enough to be carried anywhere. A motor and series of cams attached to a variable resistor vary the 2-millisecond, 40-per-second pulse output of a standard nerve stimulator from zero to about three volts at the respiratory rate.

In using the device, the physician makes a small incision in the patient's chest and attaches a silver electrode to the phrenic nerve. The patient will then breathe at a rate which can be governed by adjusting the instrument. The stimulator is expected to be useful not only for polio victims but also for those suffering from poisoning and electric shock. It may also replace the respirator used to resuscitate drowning people.

TO OUR READERS

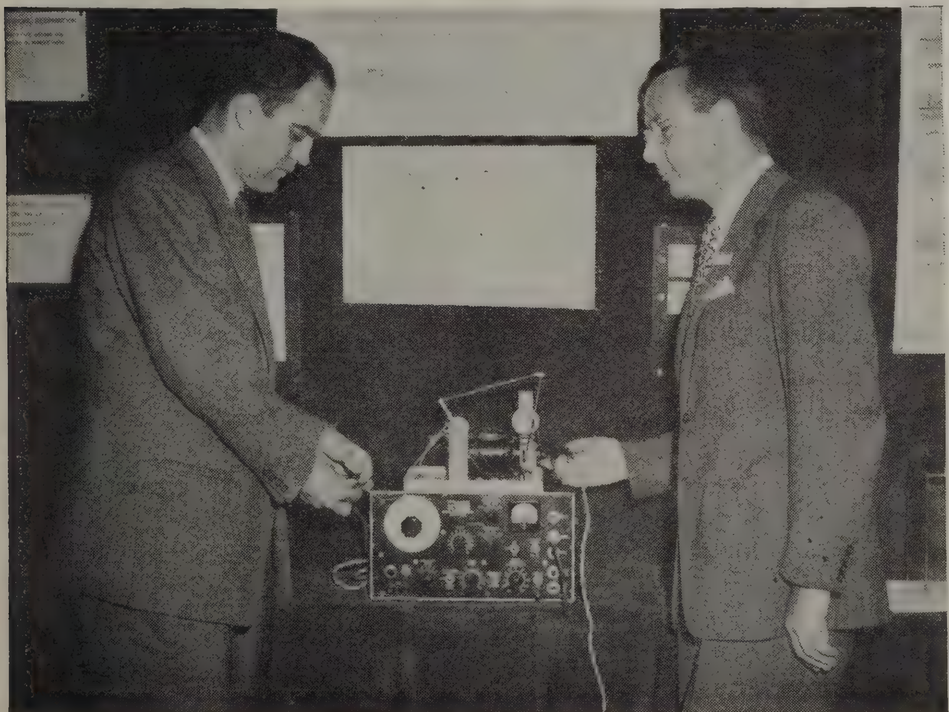
YOU have now before you the first completely revamped and improved copy of the "new look" RADIO-CRAFT. The entire issue is now printed on a super-calendered paper stock; the magazine has been increased to 100 pages; color has been added throughout many pages; and the magazine has now been completely departmentalized, omitting all continuations. *This is only a start!* Further improvements will be made continuously.

We hope that you will be pleased with your magazine—your comments will be appreciated by

THE PUBLISHERS

FIRST 3-WAY TELECAST was made by NBC last July. The broadcast, held in connection with the Democratic convention, featured James W. Girard, former U. S. ambassador to Germany, who was in New York, Clinton Anderson, Secretary of Agriculture, in Philadelphia, and David A. Morse, acting Secretary of Labor, in Washington. The voices of all three were heard simultaneously and the picture of each appeared as he spoke during the informal conversation.

To make the broadcast possible, video signals from Philadelphia were sent to New York via the Philco microwave relay and the Washington signals were transmitted to New York on the north-bound co-axial cable. These, together with the signals originating in New York, were all available at the New York master switching panel. All that was necessary each time a new voice spoke was to throw the proper switch to send the speaker's picture to the New York transmitter (WNBT) and through the south-bound co-axial cable to the other stations of the network. An interesting point is that video originating in Philadelphia and Washington was sent to local receivers in those cities only after passing up to New York for switching and then back again via the regular network cable.



Dr. James L. Whittenberger and S. J. Sarnoff with their electronic nerve stimulator.

TV REALLOCATIONS will have a profound effect on broadcasters and receiver owners, said John A. Willoughby, acting FCC chief engineer last month. Emphasizing the fact that he was speaking only for himself and not on behalf of the commission, Mr. Willoughby said the lower end of the present television band (channels 1-6) may be wiped out in two years, to make way for fixed and mobile services which require the space. Channels 7-13 will be used for TV for perhaps 10 years, in Mr. Willoughby's opinion, but only for "low-definition" transmission. The area above 500 mc will be used for high-definition black-and-white and color transmission, which may come in two years.

According to Mr. Willoughby, a television station starting operation on a low-frequency channel in the next two years is faced with possible loss of its transmitter and antenna investment. It follows that receiver owners would also take some loss, even if only that required to purchase conversion units.

FCC hearings on the TV allocation problem will begin September 20.

RAILROAD TELEPHONE service will be inaugurated soon on the 436-mile run between New York and Buffalo, Fred H. Baird, general passenger agent of the New York Central announced last month. This is the longest distance over which such a service has been planned to date. It is the first installation to be operated on the frequencies assigned for general highway mobile radio use in the 30-44-mc band.

Transmissions will be between the train, which will use a special type of antenna, and nine Bell System fixed stations spotted along the right of way. FM will be employed. Passengers will be able to make a telephone call from the train at any time during the journey.

Plans are made to extend the service over the remaining 525 miles between Buffalo and Chicago as soon as more fixed stations are ready.

ELECTROCUTION of Mrs. Harold E. Wiseman of Youngstown, Ohio, occurred last month when a radio she had placed on the edge of the bathtub fell into the bathtub. Death was swift and sure.

This is the third such death reported in RADIO-CRAFT in three months; many more have been unreported.

Every radio man realizes the great risk taken by any person who places a radio within reach of the bathtub or sink. It is up to radio men to warn their friends and customers that the mixture of radio and water may be even more dangerous than gasoline and alcohol.

WALKIE-TALKIES were used by 100 student surveyors of Rensselaer Polytechnic Institute in a 3-week field study concluded last month in the Poultney, Vt., region. As the field men read their instruments they reported the findings by radio directly to the central office at Green Mountain Junior College. As a result, tabulation and mapping kept pace with field work.

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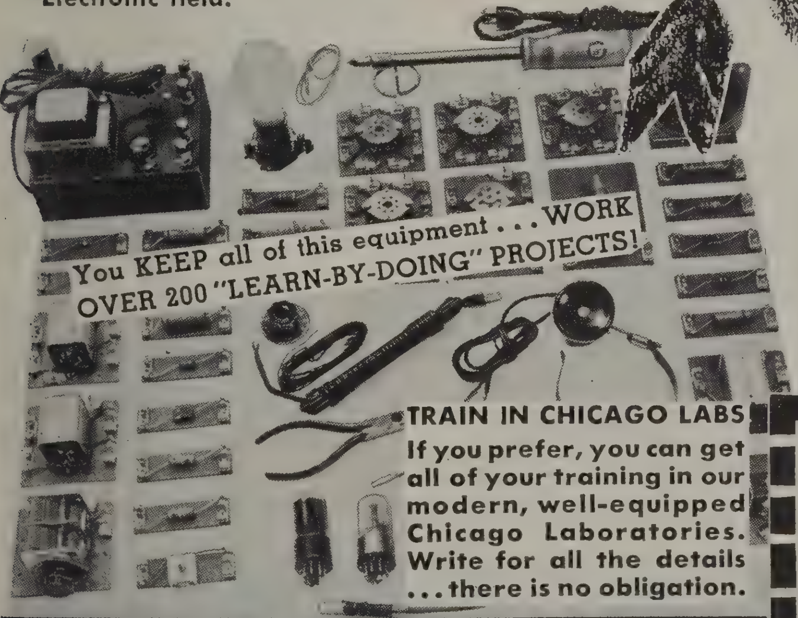
Using the many shipments of parts and assemblies (*left*), you build and keep this 6-tube "Superhet" Receiver and jewel-bearing Multi-Meter (*above*) to give you practical experience AT HOME in *ASSEMBLY . . . WIRING . . . SOLDERING . . . TESTING . . . TROUBLE SHOOTING!*



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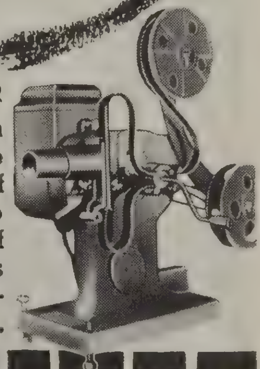

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☐ If a discharged veteran of World War II, check here.

VIDEO AUDIENCE SURVEYED

Stanley H. Manson, advertising manager of Stromberg-Carlson, revealed in a recent survey that 72% of the leisure time which television owners now spend viewing their television sets was formerly spent listening to radio. By way of comparison, a recent survey of Foote, Cone and Belding, advertising agency, shows that three-fourths of the television set owners interviewed are spending more evenings at home. Slightly more than half are going to the movies less often, although formerly they were confirmed and in most cases very heavy movie-goers.

Age of the television set did not appear to have any relationship to reported changes in movie-going habits, which tends to discount the theory that television's effect on evenings-out will diminish as the novelty of the new set wears off.

In the Stromberg-Carlson survey 60% were somewhat disappointed with their sets (mainly poor programming), 82% judged the video picture image "very good," 99% said they would buy a set again, 35% are interested in buying a second receiver, and 84% of all income groups expressed a desire to own a television set.

Although 73% now own table model sets and 27% consoles, 51% of those interviewed now want a console with all services, and while 86% of the owners had receivers with 10-inch tubes or smaller, 48% said they would insist on a larger tube in their next set, with the 12- and 15-inch most popular. Prices non-owners would be willing to pay is considerably lower than the price range satisfactory to owners. Thirty-five per cent of non-owners said $400 or less, another 35% said $400-$600 and 30% over $600. The study also indicated that in 75% of the cases the man of the house made the purchase decision, a high percentage compared to the sale of radio combinations.

Another interesting survey was made recently by Newell-Emmett Company, advertising agency. "Videotown-USA," a test television community has been selected to analyze the present television market and watch the growth of television over a period of time. Sets purchased in Videotown, located on the fringe of New York's television area, seem to be following the national average. The survey shows television ownership is in the middle-socio-economic group. Nearly two out of three sets are in the middle level. The actual breakdown shows that 60% of the sets are in the middle class; 26% in the upper and 14% in the lower. These figures compare closely with a survey made by television station WPIX in New York City recently.

The percentage of home sets is increasing rapidly. During the first half of 1947 41% were commercial installations. By the second half it dropped to 26%. The first three months of 1948 home percentage increased to 91% and the commercial installations dropped to 9%.

TELEVISION HELPS TAVERNS

Bell Television, Inc., which rents sets to tavern owners, recently made a survey in the New York Metropolitan area to measure results in this field.

To the question, "Do you believe all bars will eventually have television sets?" 64% said yes, 19% said no and 17% were undecided. Fifty-seven percent stated that television increased business profit from 10% to 60%, averaging 16%; 34% reported no change in business; 9% noted a decrease.

Of all tavern owners interviewed, 67% had television receivers. Of that group 70% owned the sets while 30% rented them.

SPECIAL AUDIO-SOUND ISSUE

The October number will be a special Audio-Sound issue. Articles on public address systems, noise reduction, binaural audio systems, electronic organs, amplifiers, pickups and other audio-sound equipment and accessories will feature this issue. Reserve your copy at your newsstand NOW!

VIDEO TUBE PRODUCTION

Sylvania Electric Products, Inc., has entered a new financing program to aid in the expansion of cathode ray facilities. "The rate at which television is expanding makes it evident that more facilities will be urgently needed to meet the demand," said Don G. Mitchell, president.

At the present time, in excess of 95% of cathode ray tube production is for new television sets. Each set, however, constitutes a future replacement market. This is just beginning to develop and will grow as more sets come into use. Sylvania's expansion plans will be geared to both the new and the replacement markets."

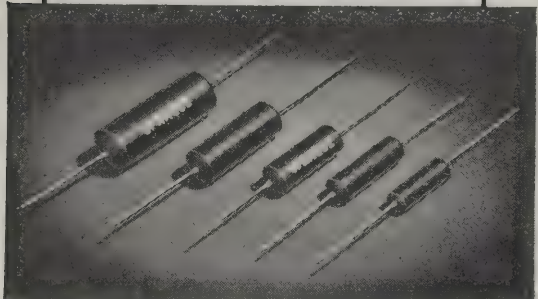
BUYING OF TV SETS INCREASES

An increase of 37% in the ownership of television sets from May 1 to June 15 has been reported by Dr. George A. Gallup's Audience Research, Inc. This represents approximately 354,000 sets. From the same source it was learned that an additional 5,400,000 families would be in the market for sets priced around $200, compared with a potential market of 2,000,000 for sets at $400, the average current price. It was estimated that 1,000,000 additional families will purchase sets within the next year, and that the entire television area now covers more than 11,000,000 families.

RADIO FAMILIES INCREASE

The Broadcast Measurement Bureau reports 37,623,000 United States families now own one or more radio sets in good working order. This represents 94.2% of the total families and compares with 33,998,000 ownership, or 90.4%, in 1946.

Buy WHERE YOU SEE THIS BANNER . . . *because* IT'S BETTER FOR YOU!



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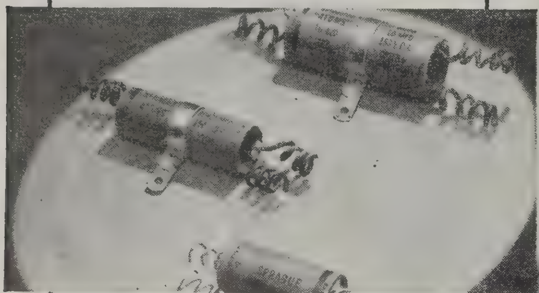

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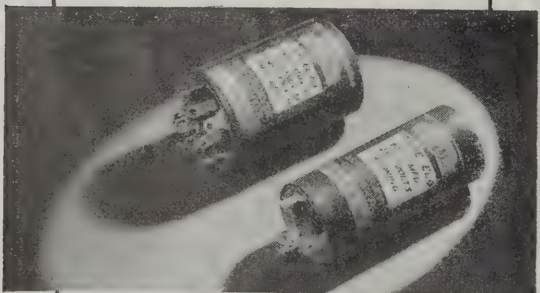

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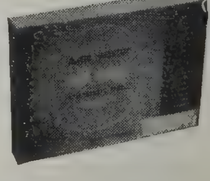

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SOVIET RADIO LAND-TORPEDO

A novel radio-telemechanic war means . . .

By HUGO GERNSBACK

DURING World War II the Russians employed a unique type of radio land mine which was used extensively against the Germans. Very little about it has been published up to now. We are indebted to the French periodical *La Nature*, from which the writer has abstracted the following highly informative account:

Up to a few years ago it was common practice to stop advancing enemy troops by blowing up buildings and fortifications by means of time bombs. The French population well remembers the terrible explosions which took place regularly several days after the Nazis evacuated French cities. No sooner did the city go back to its routine life than public buildings began to blow up, terrorizing the population. These explosions in most cases were set off by clockwork or by the well-known means of slow working acids which corrode metal diaphragms to activate the explosive charge.

A much more up-to-date means was used by the Russians beginning in 1942, with their radio mines, type F10.

F10 is a square metal housing which contains a radio receiver to which is attached an antenna 100 ft. long. Connected to the receiver are one or more mines.

A Russian model known as BIS could explode 36 mines simultaneously. These mines were electrically connected with each other. The various mines are placed about 50 yards distant from the *commandoreceiver* F10. By using an auxiliary amplifier type, BEREDO, it is possible to separate the mines a great deal farther.

The receiver is housed in a waterproof rubber sack to keep out moisture, rain, etc. The whole is buried to a depth of about 10 feet. The mines themselves can be placed in the ground or under walls, into foundations, etc.

The antenna is camouflaged carefully somewhere along the wall. F10 is equipped with an ingenious mechanical device. If technical trouble develops and the mines should not function, the entire radio receiver is destroyed so it cannot fall into enemy hands.

The installation uses a 12 volt storage battery for "A" current and a 90 volt "B" battery. Using a special clockwork, the receiver is put into operation every five minutes, but only for 10 to 15 seconds. This safeguards the installation in many ways and conserves batteries. Thus, it is possible to operate the F10 for as long as 40 days after it has been installed.

The distant transmitter sends out a series of precisely defined signals. At the receiver they are amplified and passed on to a system of three accurately tuned relays. Only when the three exactly registering pulses open a special cipher circuit is it possible to operate the detonator, which then explodes the mine or mines.

The transmitters used were standard Russian types. In order to explode the F10 mines, these transmitters had to send out special low-frequency impulses. The signals were sent four seconds apart.

The F10 wreaked tremendous havoc against the *Wehrmacht*. This continued for quite a while until by accident three installations were found intact. Now there began a technical war against the Russians. It was soon found that by using special amplifiers the clockwork could be heard up to about 20 feet, whereas without amplifiers it could only be heard about 1 foot away. Detection work, however, was exceedingly difficult and nerve-racking for the Germans, who knew that at any instant a Russian *commandotransmitter* might start transmitting and blow up F10 in their faces.

Even after F10 had been located, it was absolutely necessary to act with lightning rapidity, as in any given moment whole blocks could be blown up by the distant Russian commandoradio transmitters. The antenna had to be located quickly so it could be cut as close to the receiver as possible in order to reduce the sensitivity of the buried receiver. Then the batteries had to be disconnected, the clock mechanism put out of order, and the special mechanical delay detonator made harmless. Naturally, only specialists could do this tremendously difficult work.

The Germans evolved many countermeasures, but finally the following proved effective. Using 20 different receivers the Intelligence Service tried continuously to intercept the special signals. Using two special 100-watt transmitters operating continuously, the Nazis began sending out counter signals on exactly the same frequency. Two reserve transmitters also of 100 watts stood ready to take over in case the first two should be put out of commission. Further, a 1½ kw transmitter stood by in order to blank out the Russian signals with powerful counter transmitters. This *Störsignal* (counter signal) was transmitted as long as the Russian transmitter was on the air. The Russians countered the Nazi means by increasing *their* transmission power over 1½ kw to blank out the Germans in turn.

In practice, however, the Germans—usually being nearer to the buried receivers—were able to come out on top in this interesting radio battle.

COVER FEATURE

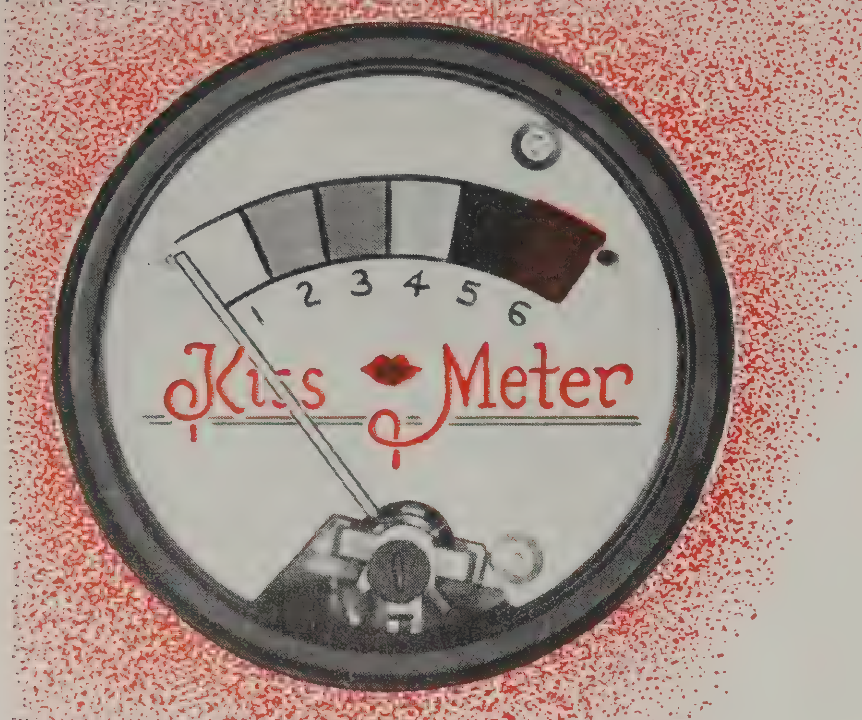


FIG. 1

Electronic Osculation Indicator

By LYMAN E. GREENLEE

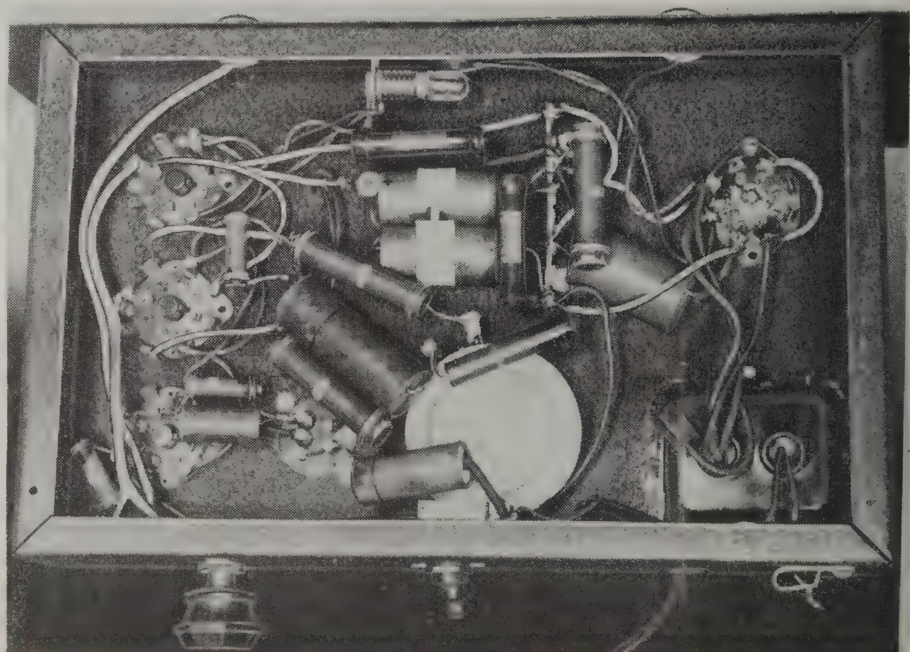
THE Kiss Meter is a scientific instrument designed to measure oscillation reaction. With it you can tell whether blondes have more resistance than brunettes or redheads. An adept Lothario can probably find this out without the aids of science, but the meter gives us a good insight into biological electronics.

The meter measures the a.c. impedance of the human body at a frequency of about 400 cycles. Two electrodes formed of spring brass or copper are shaped to fit the wrists of the two persons undergoing the test. The electrodes are connected to the meter terminals. The applied a.c. voltage is very small, and this reduces the possibility of a disagreeable shock to the experimenters. Actually there is little or no sensation to be felt, although a very sensitive person will usually imagine that there is a slight tingling effect. A vacuum-tube voltmeter is required for adequate sensitivity. A balanced bridge circuit was chosen to insure stability.

A large cabinet happened to be on hand. Its use makes the instrum^nt look impressive, but there would be plenty of room in a smaller case. As Fig. 2 indicates two 6J5's are used in a bridge circuit with a 0-200 or 0-500 microammeter to form a stable, highly sensitive vacuum-tube voltmeter. If a 0-500-μa meter is used, the 1,500-ohm shunt will not be needed. A special scale (shown in Fig. 1) was drawn for the meter on white bristol board and colored to represent six degrees of osculatory intensity: 1 white, 2 blue, 3 green, 4 yellow, 5 orange, and 6 red. This covers the whole emotional range from "frigid" to "torrid."

A third 6J5 is used to generate the 400-cycle current for making the impedance measurements. A small push-pull output transformer was used, with the 6J5 cathode connected to the center tap of the secondary. No capacitor was necessary across the secondary winding with the particular transformer used, but some transformers may require about .005 μf. The output is taken from the voice-coil winding. This keeps the voltage low enough so that little or no shock can be felt. Some transformers may not work successfully in this circuit. In case of difficulty try another transformer.

The power supply uses a 7Y4 connected as a half-wave rectifier and a small power transformer from a midget radio. If a center-tapped transformer is used, half the secondary winding may be disregarded. Since there was no separate filament winding for the rectifier on the power transformer used in the model, all the tubes were operated from the same 6.3-volt secondary; but, if a separate winding is available for the rectifier, it should be used to avoid excessive voltage between heaters and cathodes of the other tubes. Note that the output from the power supply is con-



Under-chassis view of the Kiss Meter. Sensitivity control is at back, zero on chassis.

BIOLOGICAL ELECTRONICS — By HUGO GERNSBACK

WHEN the accompanying article by Mr. Greenlee was first received, it was thought that its publication might strike some individuals as too fanciful. But, biological electronics being something rather new, I believe it deserves a great deal more publicity. There is much to be learned about the effect of disease on the human anatomy, and it is quite possible that in the future we may investigate many diseases and illnesses by means of electronics.

Karl Friedrich Burdach, German physiologist and biologist, probably was the first scientist to investigate human osculation. He defined it as a "Galvanic contact between a positively and negatively electrified body: it increases sexual polarity and permeates the entire body."

Since this early pronouncement, nearly 100 years ago, other scientists have preoccupied themselves with the subject, particularly on the basis of sexual selection. The propagation of the human race depends upon many factors; and many of our senses are involved in this selection, be they visual, oral, or tactile. Osculation is one of these, and up to now it has not been investigated too seriously.

Dr. G. W. Crile has demonstrated that the human life stream is continuously discharging electrical potential. It is a fact that many parts of the human animal are actively affected by *galvanotropism*—response of living things to electric stimuli.

It has been shown experimentally that during the act of kissing there is an actual exchange of electrical potential as well. Although only a weak current, it exists nevertheless.

Some years ago the writer did some research work along these lines and the following were noted:

To begin with, lips are covered with a mucoid membranous skin. This very sensitive skin is subject to many and varied influences. In different individuals and in different races, for instance, the thickness varies a great deal. Speaking generally, the male lip has somewhat thicker skin than the female. Age changes the thickness and consistency of this skin a great deal. Repeated measurements with an electrical potential have shown that the electrical response of the lip skin varies over a wide range. Thus, as might be expected, pressure affects the resistance. So does lipstick, which sometimes increases the electrical resistance, depending on the type used.

Moisture, of course, lowers the resistance a great deal, the degree depending upon the nature of the moisture. If the lips are moistened with the tongue, the resistance varies greatly with the state of health of the individual as well as with what foods had been ingested. Thus, for instance, the lip response of an individual was measured before and after drinking lemonade. After drinking this acidulous liquid, the resistance of the lip skin fell almost to the lowest point.

It was also found that emotions greatly affect electrical resistance of the human lip skin. Thus, fright—as is well known—dries up mucoid skin, and under this influence the resistance went up enormously. We all know from experience that during great emotional stress, such as fright, shock, etc., most individuals automatically lick their parched lips, which have become almost completely dry with an accompanying increase of electrical resistance.

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nected to a voltage divider to supply about 150 volts positive plate potential, and 80 volts negative bias. No filter, other than the single 8-μf electrolytic capacitor and the two 2-μf electrolytics, is required. Larger capacitors can be used, but they are not necessary.

A 1-megohm potentiometer shunted with a 250,000-ohm resistor controls the input sensitivity, but a 200,000-ohm potentiometer may be used without the resistor. The 5,000-ohm zero-adjustment potentiometer should be wire-wound.

Fig. 2 shows two .005-μf capacitors connected across the input of the power transformer and grounded to the chassis. A single .005-μf capacitor connected directly across the line may also be tried. The meter is very sensitive and has a tendency to respond to any 60-cycle a.c. voltage introduced between the chassis and either side of the power line. In some cases it may be necessary to reverse the a.c. line plug or have the users stand on rubber matting.

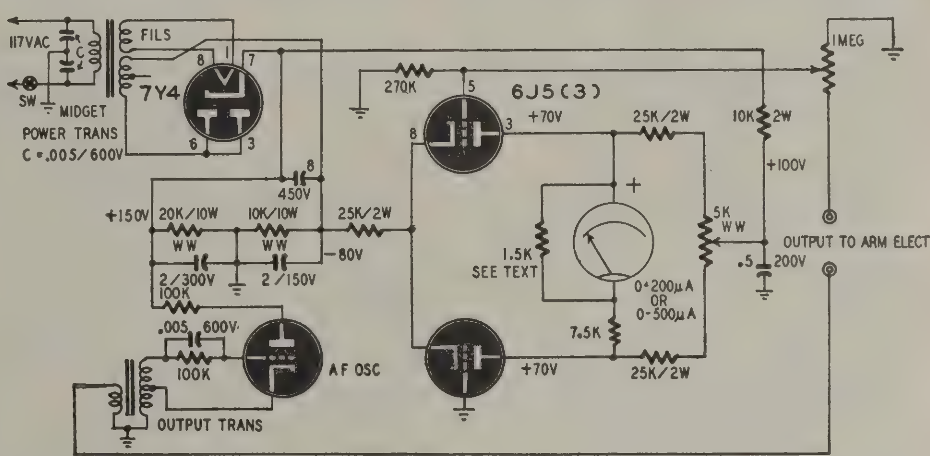


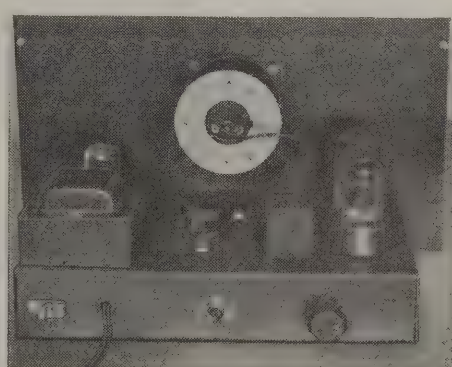
Fig. 2—Schematic. With some transformers, the oscillator plate may need bypassing to ground.

The photographs show the wiring and placement of parts. The correct voltages at various points in the circuit are indicated in Fig. 2. These voltages were all measured from chassis using a 1,000-ohms-per-volt meter. If correct voltages do not appear, vary the resistors in the voltage-divider circuit until voltages are correct. It may be necessary to insert an additional resistor in series with the 20,000-ohm bleeder to cut the plate voltage at this point to 150.

The two controls that require adjustment are mounted, one at the rear and one on the top of the chassis, to prevent tampering with the calibration. The 5,000-ohm potentiometer is used to adjust the zero point of the meter with the arm electrodes disconnected. The 1-megohm potentiometer is used to set the sensitivity so that the meter reads full-scale with the arm electrodes shorted together. These are the only two adjustments required and they will rarely need to be altered, as the instrument is very stable in operation.

To insure adequate contact with the experimenter's wrist, it is a good idea to dampen the spring contactors with a little salt water. Small wads of cotton soaked with salt water or vinegar can be inserted between wrist and wristbands for better contact, if necessary.

The instrument was constructed for a specialized purpose, but the circuit might find much wider use. It is an a.c. impedance meter, which could easily be used to check inductors and capacitors, resistors, etc. For such purposes a multi-scale instrument would perhaps be desirable. The author has not tried to adapt the instrument to the service bench, but the idea is attractive.



The chassis is much smaller than the cabinet.

Transistor—germanium crystal that oscillates and amplifies

Eclipse of the Radio Tube

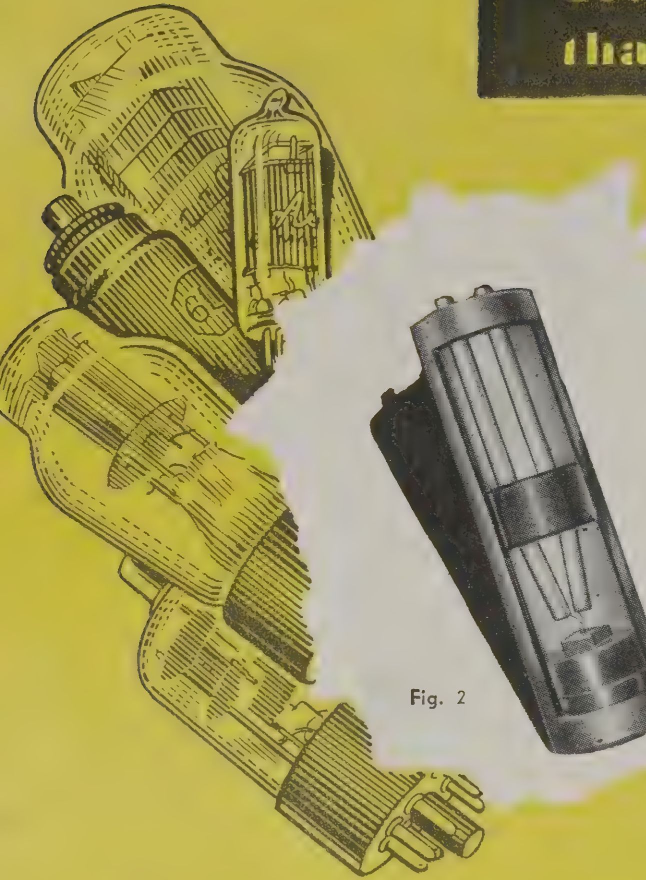


Fig. 2

THE beginning of the end of an era in radio—the era of the vacuum tube—was heralded on June 30 when the Bell Telephone Laboratories demonstrated a simple, revolutionary replacement for the vacuum tube.

Although still only a laboratory development, this device, known as a *transistor*, will do everything that the conventional vacuum tube can do, i.e.: amplify and oscillate. Yet, it consists of nothing more than a tiny piece of germanium crystal (similar to the 1N34) soldered to a metal base with two phosphor bronze or tungsten points spaced only .002 inch apart making contact with the top surface. The whole is inclosed in a metal cylinder less than an inch long (see Fig. 1). The device operates at normal room temperatures, and —unlike the vacuum tube—requires no cathode heating or vacuum.

A cross-sectional view of the device is shown in Fig. 2. The two hair-thin contacts and the germanium crystal can be clearly seen.

The implications of this development, once it emerges from the laboratory and is placed in commercial channels, are staggering. No longer will it be necessary to supply power—whether it be by batteries or filament heating transformers—to heat an electron-emitting cathode to incandescence. The transistor requires only two low-voltage, low-current bias-voltage sources to operate as an amplifier or oscillator. Lighter and smaller pocket radio sets will be one of obvious results. Cheaper receivers will be possible because of the elimination of heater and filament circuits.

The first transistors have voltage gains of approximately 10, roughly the equivalent of a medium-mu triode.

There are two limitations on the use of the transistor at the present state of its development.

The first is the maximum frequency at which it will operate satisfactorily. 10 megacycles is the present upper limit.

The second limitation is the amount of power which can be developed in the units. This is 50 milliwatts. However, the maximum frequency and power limits of the transistor have not yet been explored and it is quite probable that with the knowledge gained from more experience in their use and manufacture, both figures will be raised.

A table model radio broadcast receiver using no vacuum tubes was demonstrated. This receiver was a modification of a commercial vacuum-tube receiver. purchased in the open market.

Another tubeless set—the equivalent of a line-operated 10-tube conventional broadcast superheterodyne receiver—was also demonstrated.

In another demonstration a two-stage video amplifier incorporating two transistors was connected in series with the video line to a television receiver monitor to illustrate the low-distortion wide-range amplification of the device.

Fig. 3 shows a complete plug-in audio oscillator unit. The unit contains a transistor, a transformer, two condensers, and two resistors. The four-prong tube base of this unit connects to the necessary batteries and to a loudspeaker. This unit performed exactly the same as a vacuum-tube audio oscillator.

Transistor circuits

As far as circuit applications are concerned, the transistor may be compared to the conventional vacuum tube triode.

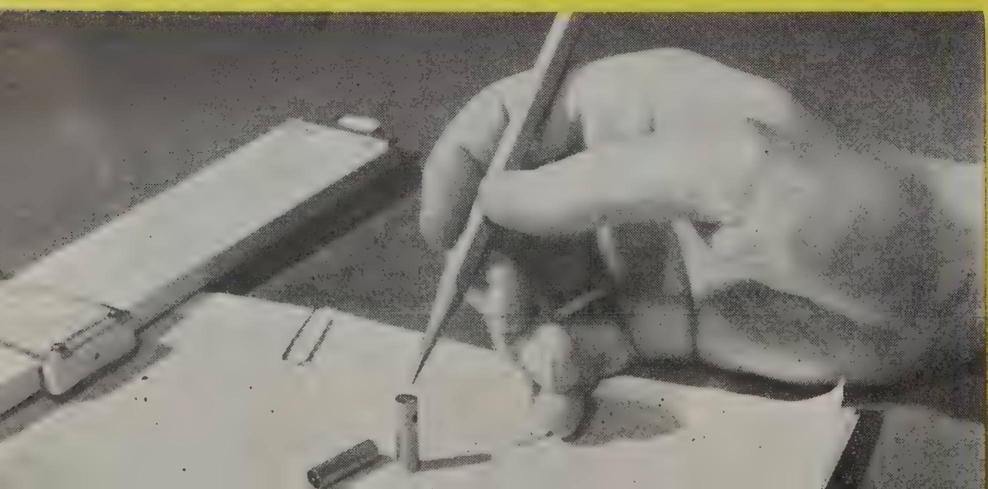


Fig. 1—This photograph shows how small the amplifying unit is. The crystal and the two contacts are enclosed within a tiny cylinder.

In fact, the transistor is defined as a semi-conductor triode.

Fig. 4 is a simplified schematic diagram of a typical amplifying circuit using a transistor.

The circuit looks very similar to a conventional triode circuit, if the emitter contact is considered as the control grid and the collector contact as the plate, with the semi-conductor base as the cathode.

Unlike the vacuum tube, however, the emitter contact is biased with a small positive voltage (1 volt) while the collector (or output) contact is supplied with a negative potential of approximately 45 volts.

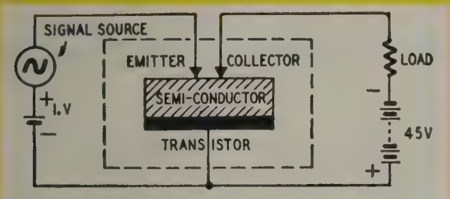


Fig. 4—This is basic transistor amplifier.

Another fundamental difference is that the input impedance of the transistor is low, ranging from 200 to 1,000 ohms. Output impedance ranges from 10,000 to 100,000 ohms. Thus, the transistor can be matched to a high impedance load. Because of the low input impedance it will be necessary to use special input circuit arrangements.

Gain can be varied by varying the amount of bias applied to the emitter contact, much as gain in a triode can be varied by changing the grid bias.

The transistor can be used in any type of oscillator circuit where a vacuum tube triode can be used. Fig. 5 shows one oscillator circuit.

Transistor development

The transistor is the outgrowth of experiments and theoretical studies of semi-conductor phenomena by Dr. William Shockley of the Bell Telephone Laboratories, assisted by Drs. Walter Brattain and John Bardeen.

In critically examining the implications of the prevailing theory of electrical conduction in semi-conductors, Dr. Shockley was able to predict that it should be possible to control the meager supply of electrons inside a semi-conductor by influencing them with an electric field imposed from the outside without actually contacting the material. Realizing the practical implications of such a possibility he devised some experiments to test his hypothesis but was unable to secure positive results. The electrons seemed to get trapped in the surface of the material and did not behave just as anticipated.

This part of the problem was tackled on a theoretical basis by Dr. Bardeen. He developed a theory of what happened at the surface which was able to explain satisfactorily many of the observed facts and which led to further experiments carried out in collaboration with Dr. Brattain. In the course of these experiments they invented transistors.

Transistor action depends upon the fact that electrons in a semi-conductor can carry current in two distinctly different ways. This is because most of the electrons in a semi-conductor do not contribute to carrying the current at all. Instead they are held in fixed positions and act as a rigid cement to bind together the atoms in a solid. Only if one of these electrons gets out of place, or if another electron is introduced in one of a number of ways, can current be carried. If, on the other hand, one of the electrons normally present in the cement is removed, then the "hole" left behind it can move like a bubble in a liquid and thus carry current.

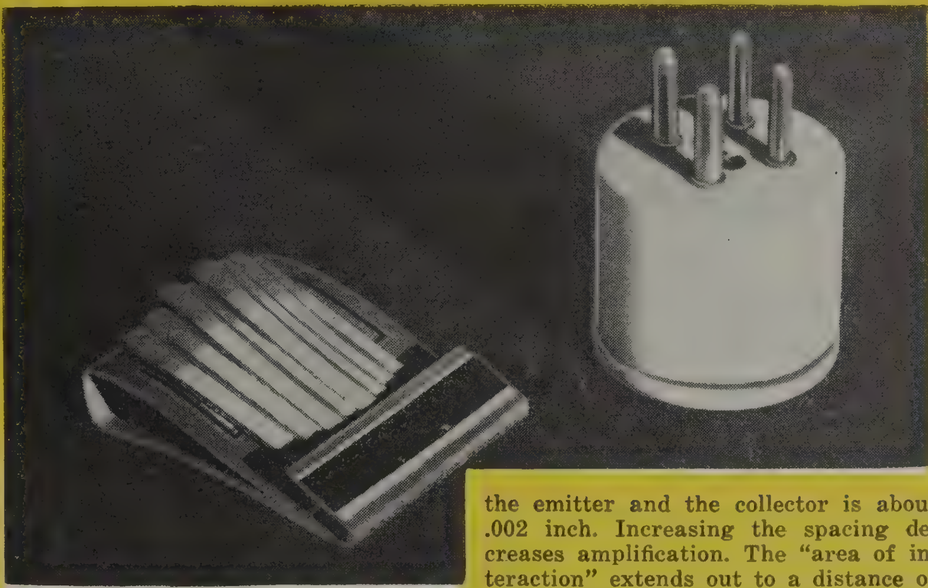


Fig. 3—Transistor plugs into a tube socket.

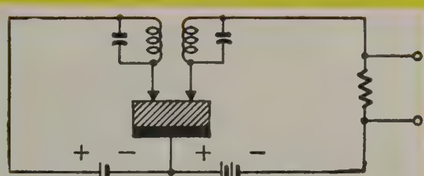


Fig. 5—Transistor replaces oscillator tube.

Fig. 6-a represents a cross-section of a germanium crystal with a positive voltage applied through a point contact (the emitter).

The current flow under this condition does not fan out from the emitter contact point through the body of the crystal material to the base, but instead spreads out widely over the surface of the crystal somewhat like water spreads out on top of a non-porous surface such as glass. This current flow across the surface is carried by the *holes*.

The amplification process can be understood in terms of the discovery that the emitter point is surrounded by an "area of interaction." Within this area the electronic structure of the semi-conductor is modified by the input current. Now, if the output point (the collector) is placed in this area and a negative bias applied to it the output current can be controlled by the input current. This control of output current by input current is the basic mechanism of amplification. The optimum spacing between the emitter and the collector is about .002 inch. Increasing the spacing decreases amplification. The "area of interaction" extends out to a distance of about .01 inch from the emitter point.

If the negative collector bias is made large enough to make the collector current equal to, or larger than the emitter current, the polarity of the collector bias will attract the *holes* flowing from the emitter (Fig. 6-b). Then a large part of the emitter current flows to (and enters) the collector. While the collector has a high impedance to the flow of electrons into the crystal semi-conductor, there is little opposition to the flow of the holes into the collector point. If the emitter current is varied by feeding in an a.c. signal, the collector current varies correspondingly. The flow of holes from the emitter to the collector may alter the normal current flow from the crystal base to the collector in such a way that the change in collector current will actually be larger than the change in emitter current; in effect, amplification.

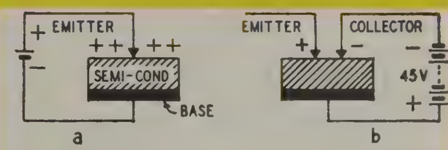


Fig. 6—This shows how transistor amplifies.

Historical background

In 1923 a Russian, O. V. Lossev, claimed to have successfully caused a crystal detector to oscillate and amplify. An account was published in the September, 1924, issue of one of Hugo Gernsback's former radio publications. Unlike the transistor, this arrangement (called the crystodyne) made use of a 2-contact crystal detector and relied on special circuits to get the desired results. Results were poor.

In the early part of this century Dr. Greenleaf W. Pickard produced oscillations with a crystal detector circuit. The circuit, however, was impractical. Pickard said:

"Any contact which doesn't obey Ohm's law can be used to produce oscillations. A crystal rectifier can also be made to amplify—although the simple contact must be changed to something more complex."

The Crystal Detector

Part III—Modern crystal cartridges

By JORDAN McQUAY

THE technique of high-frequency rectification with crystals or minerals is almost as old as radio itself. Beginning in 1902, Pickard and other pioneers developed the crystal detector which, until supplanted by the more efficient vacuum tube[1], was the chief means of radio reception. Decades later, modernized and improved crystal rectifiers returned to become the sole method of frequency conversion for microwave superheterodynes[2]. So successful were these rectifier cartridges that other types were soon developed for other rectifying purposes at radio and audio frequencies as well as at power frequencies.

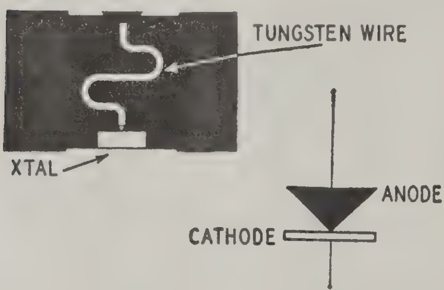


Fig. 1—Construction of the crystal rectifier.

All modern crystal cartridges are essentially *point-contact rectifiers* (Fig. 1) having a small-area contact between a wire of tungsten or similar metal and a semiconductor of either silicon or germanium.

Semiconductors constitute a special class of materials between conducting and nonconducting solids. They have a high electrical resistance, between that of metals and insulators, and are much more sensitive to the presence of impurities than are metals.

If small amounts of certain impurities are added to either silicon or germanium, the resulting material can be made to function *nonlinearly* (*not* in accordance with Ohm's law) when placed in contact with a suitable conductor of fine wire. The nonlinear characteristic is decidedly polarized, as shown in Fig. 2. This curve reveals an important characteristic: the *back-to-front ratio* determined by the resistance of the rectifier in the front and back directions.

Rectification takes place across a *potential barrier* produced at the contact point of the semiconductor, due to the difference in functioning between the metal conductor and the semiconductor. The barrier permits a flow of electrons from the semiconductor to the metal wire, but prevents electron flow in the opposite direction[3].

This rectifying action is made possible by the inclusion of a small percentage of certain impurities, sometimes known as *doping ingredients*, in the basic, bulk material, silicon or germanium. Conduction depends upon impurities on the order of 0.1%. By rigid control of these impurities, the characteristics of a contact rectifier can be altered to satisfy any electrical requirement [3, 4]. Besides bettering the performance of existing types of rectifier cartridges, improved methods of doping semiconductors have led to many different crystal types for various circuit applications. See Tables 1, 2, and 3.

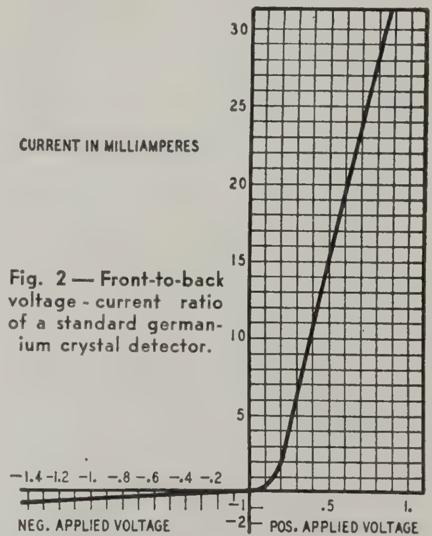


Fig. 2 — Front-to-back voltage - current ratio of a standard germanium crystal detector.

Silicon rectifiers

A majority of the modern types of crystal cartridges (Fig. 3) developed during and since the war are for use as mixers or frequency converters in microwave superheterodyne receivers. (See Table 1.) Also, numerous types of rectifiers known as video detectors have been developed for direct demodulation of microwave signals, without the use of a superheterodyne circuit. (See Table 2.) And one type of crystal cartridge, the 1N22, is an instrument rectifier for microwave test and measuring equipment.

For all of these functions, where the operating frequencies are on the order of 1,000 to 25,000 mc, only silicon in crystalline form is a satisfactory semiconductor.

Silicon is a nonmetallic element, with a melting point of about 2,600 degrees F. Although it is one of the most abundant elements, it is never found free in nature. The pure crystalline form, obtained by chemical reduction, is a silvery, brittle substance in the form of globules or 6-sided pyramids. Pure silicon crystal, however, is not suitable as a semiconductor.

A crystalline form is first obtained at a high temperature from silicon tetrachloride. The silicon crystals are then melted in a vacuum, and to this melt small impurities are added, according to the intended use of the finished product. For microwave mixing or frequency conversion, aluminum, beryllium, and boron are added. For video detection, nickel and germanium, with extremely small amounts of bismuth, calcium, and cobalt, are mixed with the bulk silicon.

After the impurities have been added, the substance is cooled and sawed into sections about 1 mm thick. Both sides of each section are fairly well smoothed, but one side is finished and polished.

Next, the contact surface is given an oxidizing heat treatment[5]. Each slab is heated for several hours until a blue color appears, indicating the formation of a thin oxide layer. During this oxidizing period, various impurities in the silicon diffuse into the adhering silica film, decreasng the amount of impurities on the surface of the silicon. The oxide layer is removed by a solution of

Fig. 3—Typical crystal for converter stage.

dilute hydrofluoric acid. The underlying layer of silicon is exposed and remains intact, as the acid does not readily attack the silicon. Any decrease in the impurity content of a semiconductor increases its resistance. Thus, the silicon surface has a higher resistance than before the oxidizing treatment. The characteristics of a silicon rectifier are governed by the resistance of the semiconductor, the area of contact, and the degree of surface oxidation.

In general, silicon rectifiers are confined to very-low-power circuits, usually on the order of 1 watt or less.

Although silicon could be treated for use at much lower frequencies, germanium crystal cartridges are far more efficient for that purpose.

TABLE 1
SILICON RECTIFIER CARTRIDGES
(for frequency conversion in microwave superheterodynes)

Type	Optimum Freq. (mc)	Relative Sensitivity	Max. Conversion Loss (db)	Max. Output Noise Ratio	Av. Power Input (μw)	Max. Power Input (μw)
1N21	3,000	Low	8.5	4.0	0.4	1.0
1N21A	3,000	Medium-Low	7.5	3.0	0.4	1.0
1N21B	3,000	Medium	6.5	2.0	0.5	1.0
1N21C	3,000	Medium-High	5.5	1.5	0.5	1.0
1N23	10,000	Low	10.0	10.0	0.1	1.0
1N23A	10,000	Medium-Low	8.0	8.0	0.1	1.0
1N23B	10,000	Medium	6.5	6.5	0.1	1.0
1N24	25,000	Low	14	4.0	0.2	0.5
1N25	1,000	High	8.0	2.5	7.0	20.0
1N26	25,000	Medium	8.5	2.5	0.1	1.0
1N28	3,000	High	7.5	2.5	0.4	1.0

TABLE 2
SILICON RECTIFIER CARTRIDGES
(for video detection)

Type	Optimum Freq. (mc)	Minimum Video Freq. (cycles)	Minimum Video Impedance (ohms)	Maximum Video Impedance (ohms)	Maximum Power Input (μw)
1N27	3,000	500	0	4,000	5
1N29	1,000	500	6,500	24,000	500
1N30	10,000	500	7,000	21,000	5
1N31	10,000	500	6,000	24,000	5
1N32	3,000	500	5,000	29,000	5
1N33	3,000	500	2,000	10,000	100

TABLE 3
GERMANIUM RECTIFIER CARTRIDGES
(for diode applications)

Type	Frequency Range (mc)	Maximum Inverse Voltage	Average Current (ma)	Maximum Peak Current (ma)	Maximum Surge Current (ma)
1N34	0 - 200 +	60	22.5	60	100
1N35	Consists of mounted pair of matched 1N34's for duo-diode applications.				
1N38	0 - 250 +	100	22.5	150	500
1N39	0 - 20	200	15.0	150	100

Germanium crystals

The need for crystal rectification at lower frequencies and at higher power led to the development of the germanium pigtail cartridges.

Existing types of germanium rectifiers can be operated at any frequency up to about 250 mc with a maximum back voltage of 200 and a safe maximum forward current of 150 ma. (See Table 3.) Improved types now under development will withstand inverse voltages up to 250.

The tiny cartridges are used as second detectors and d.c. restorers in television receivers, modulators and demodulators, voltage regulators, discriminators in FM circuits, volume limiters, varistors, meter rectifiers, noise silencers, and in other applications.

A matched unit, known as the 1N35 duo-diode, consists of two almost identical germanium rectifiers in a single mounting (Fig. 4). The two diodes are matched for values of forward and back resistance (within 10% at 1 volt), and are particularly desirable where full-wave rectification is required in a balanced circuit.

The highly polarized, nonlinear characteristics of all these crystal diodes are due essentially to the use of germanium (with certain impurities) as a semiconductor in contact with a sharp tungsten or platinum wire[4].

Germanium is a rare metallic element which is silver-white, lustrous, hard, and brittle, with a melting point of about 1,755 degrees F. In the electrochemical series of elements, germanium (No. 28) is considerably more electropositive than silicon (No. 45); however, the properties of the two are very similar.

Never found free in nature, germanium occurs in many sulphide ores, usually in the form of germanium dioxide. The amorphous metal is obtained by chemical reduction. Impurities are then added to improve the quality of the germanium as a semiconductor.

For efficient low-frequency rectification with high inverse voltages, antimony and tin, with extremely small amounts of calcium, nickel, and strontium, are added to the bulk germanium. These combined impurities total less than 0.1% of the whole.

After melting and cooling, the substance forms diamond-shaped crystals. The ingot is sawed into wafers about 0.6 mm thick. Each wafer is polished on one surface, and then cut into four squares, 3 mm on a side. Next a crystal wafer is silver-soldered to one wire of the cartridge, and placed in contact with a tungsten or platinum point. The isolantite cartridge is wax-filled to maintain correct adjustment and make the unit moisture-proof and shock-proof.

It is reasonable to believe that within a few years there will be sufficient types of germanium rectifiers to supplant all vacuum-tube diodes, with a consequent saving in cost, weight, volume, and filament power consumption.

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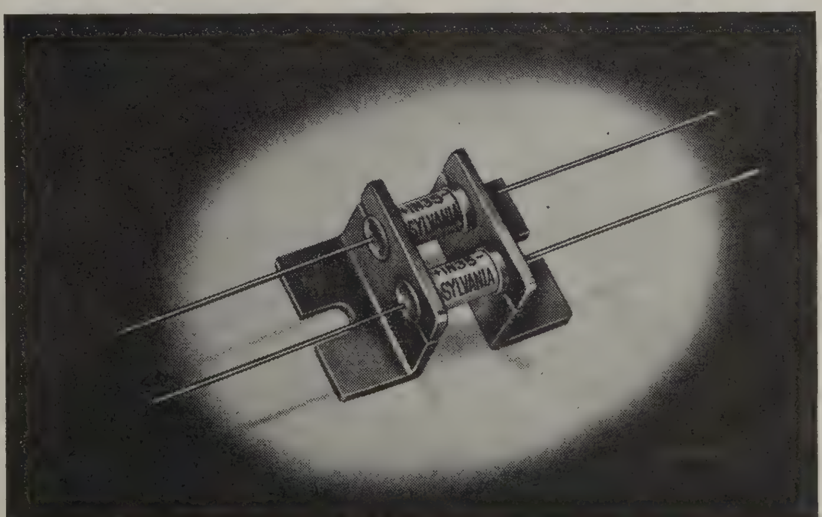


Fig. 4—These two matched detector cartridges are used in discriminator circuits.

The Sanborn Cardiette, a typical phonocardiograph

Electronics in Medicine

Part II— Phonocardiography—diagnostic use of sound amplification

By EUGENE J. THOMPSON

An electrocardiogram is a graphic record of the voltages created by the pulsing of the heart. (See RADIO-CRAFT, March, 1948.) The source of these potentials is the regularly timed nerve impulses, each section of tissue through which an impulse passes becoming momentarily electronegative with respect to the rest of the body tissue. Because these impulses cause the heart to contract and expand, measurements of their frequency and amplitude are a good indication of heart action.

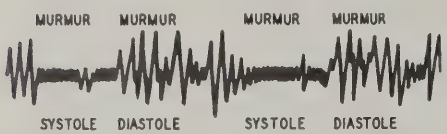


Fig. 1—Trace produced by phonocardiograph.

Electrocardiographs, which measure and make tape records of the heart potentials, have their limitations. For instance, the valves at the outlets of each of the four chambers of the heart act to allow blood to flow in one direction only—either into the heart or out of it, depending on the function of the particular outlet. Like the one-way valves in a water pump, they are made to open and close by the force of the fluid, not by any independent muscular action. The opening and closing of these valves will not have any important connection with the heart potentials, and the electrocardiograph will not show their functioning.

The movements of the valves can be detected by the sounds they make, and for many years physicians depended on their stethoscopes to hear them. The normal valve motion produces two or three characteristic sounds. When the valves become diseased and do not close completely, the leakage of blood in the wrong direction through the heart outlets produces several typical noises. The most common is the murmur.

The phonocardiograph

The sounds which help the physician to diagnose heart diseases may be very faint, and they can cover a fairly wide frequency range. The acoustical stethoscope has a limited frequency range, and it is not efficient for very low-level sounds. Therefore, a special microphone and audio amplifier are used. Known as the phonocardiograph, the instrument not only enables the physician to hear the amplified heart sounds, but also makes a permanent record of them on paper tape.

A section of this tape appears in Fig. 1. The wavy line is a picture of the heart sounds, and it represents much the same thing as an oscillograph trace would. It shows the heart sounds during the systole or dilation of the heart, during which it fills with blood, and then during the diastole or contraction, when it empties. On this tape, the sound picture indicates that the murmur is most pronounced during the diastole. Since the physician knows which set of valves ought to be closed during each movement of the heart, the diastolic murmur shows him which valves are not closing completely.

A typical phonocardiograph is pictured above. This instrument, like most phonocardiographs, makes simultaneous electrocardiograms on the same tape.

The main part of the instrument is a standard high-gain, battery-operated amplifier, shown in Fig. 2. Its output is fed to a moving-coil, optical galvanometer, which produces a photographic record on the moving light-sensitive tape. In some other models, the output audio voltage operates an electromagnetic recording lever to which a pen is attached. The technical aspects of electrocardiograph amplifiers, of which Fig. 3 is an example, were discussed in RADIO-CRAFT last March.

The frequency response of the whole system is very important in determining what type of record will be obtained on the tape. The amplifier and the recording mechanism are essentially flat. The microphone used is a high-quality crystal type with a very-wide-range response. Especially built for phonocardiographs, the case is conveniently shaped for the purpose.

A typical microphone is shown in Fig. 4. Notice that an acoustic bell is attached to it. When the physician places this against the patient's chest, all out-

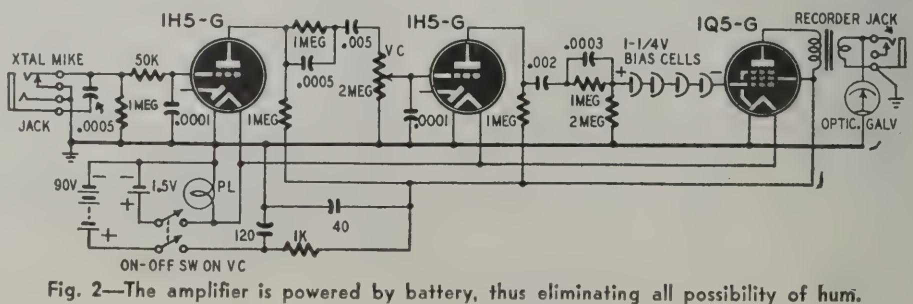
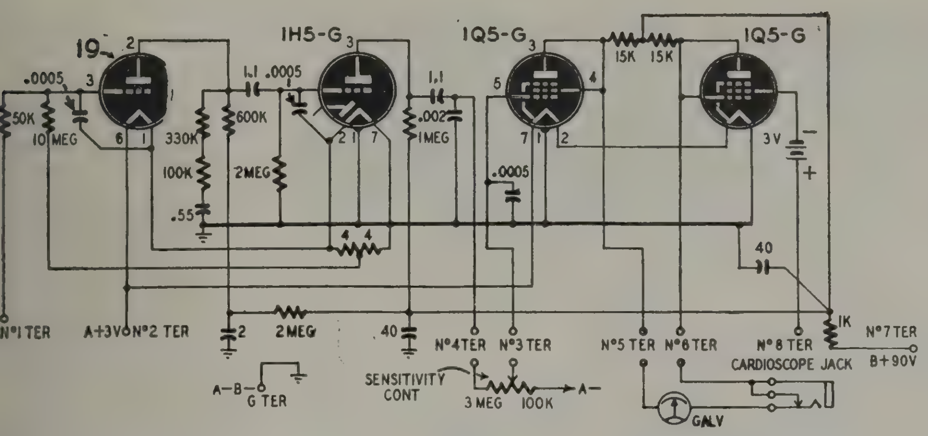


Fig. 2—The amplifier is powered by battery, thus eliminating all possibility of hum.



ig. 3—Standard electrocardiograph amplifier uses very low frequency coupling components.

ide noises are excluded so that the tape ecord is an accurate indication of heart ounds only. The size and shape of the ell affect the frequency response of the nicrophone. Increasing the size shifts mphasis to the lower frequencies; deeasing it gives a peak in the high ange. High-frequency output can also e improved by stretching the patient's kin and increasing the pressure with which the microphone is held to the hest. A number of different-size bells s usually supplied with each instrument o the physician can select the one which ccentuates the sounds he particularly vants to hear and record.

Microphones can be designed to repond to sound in two ways, linearly or garithmically. If the response is linear, ne output of the microphone for a sound which has an intensity (expressed, for xample, in dynes/cm^2) 100 times greatr than another sound will be 100 times reater than the output for the lower ound. However, if the response is logaithmic, the microphone output for the ouder sound will be equal to only twice ne output for the weaker sound (log 0=1; log 100=2).

Each of these two types of response as its advantages and disadvantages. he linear type of response is useful for etecting sounds of low intensity and or distinguishing between sounds of elatively slight differences in intensity. ften a microphone of this type is of alue in detecting very early valvular bnormalities which are below the threshold of human hearing.

The logarithmic response offers the very important advantage of closely approximating human hearing, which is logarithmic. This is important in analyzing records, because an abnormal sound which has, say, twice the amplitude of a normal sound on the visual record, will actually sound twice as loud with a stethoscope.

When heart sounds are being recorded, the physician usually listens with a stethoscope at the same time. In some apparatus such as the instrument in Fig. 3, provision is made for plugging in a set of headphones which are acoustically compensated to permit the examiner to hear a true reproduction of the amplified sounds, as recorded.

Fig. 5 shows the special equipment used in recording pulse beats. The small cup A is held against the skin over an artery by suction created by the rubber bulb B or by manual pressure. The flat disc C, connected by a rubber tube to the cup, contains a pressure-operated piezoelectric crystal. With each pulse beat, the skin moves outward. This produces a small compression of the air in the rubber tube and in the crystal chamber. The distortion of the crystal caused by the air pressure produces a small voltage which is passed through the cable and cylinder D, which contains a small shunt time-constant capacitor, to an audio amplifier. A recorder connected to the amplifier output makes tape records of the pulse beats. An interesting feature of this method of recording pulse beats is that, not only their frequency and amplitude are registered, but also their wave form, which is of considerable diagnostic value.

Another method of recording pulse beats uses a photoelectric tube. The technique, which is used for many other purposes as well, is known as photoelectric plethysmography.

Fig. 6 shows how this method is used. A light source shining through a thin part of the body (an ear lobe is used here) illuminates a phototube. Spurts of blood pass through the blood vessels each time the heart beats. The blood, coming between light source and phototube, makes the ear lobe more opaque. During the pauses between beats, blood does not flow and the lobe becomes more translucent. The light reaching the phototube depends on the translucency of the lobe, so it varies in step with the heart beats and blood spurts. The varying output of the photoelectric-tube circuit is fed to an amplifier and a wavy-line tape record is made. The amplifier used with this device must have very good low-frequency response, so direct-coupled circuits are often used. With R-C-coupled amplifiers an adapter circuit must be used, as shown in Fig. 7. Polarizing voltage is available in direct-coupled amplifiers, so no adapter is necessary.

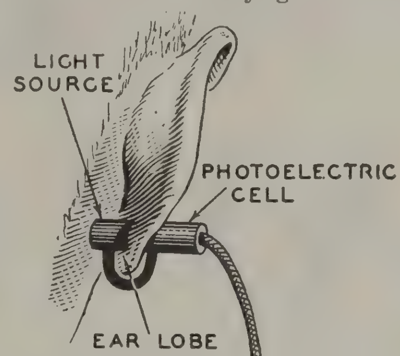


Fig. 6—Equipment for attachment to the ear.

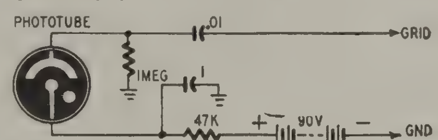
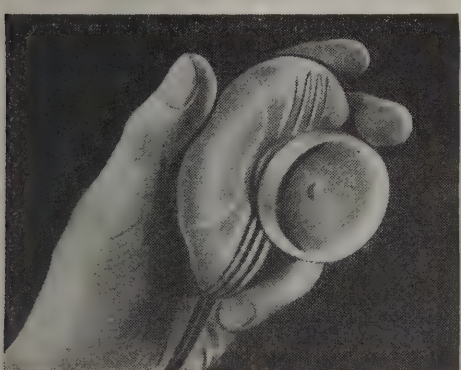


Fig. 7—Adapter for R-C coupled amplifier.



Photographs Courtesy The Sanborn Co., Cambridge, Mass.

Fig. 4—Example of a heart-sound microphone. These are high-class crystal types and may have straight or logarithmic output curves.

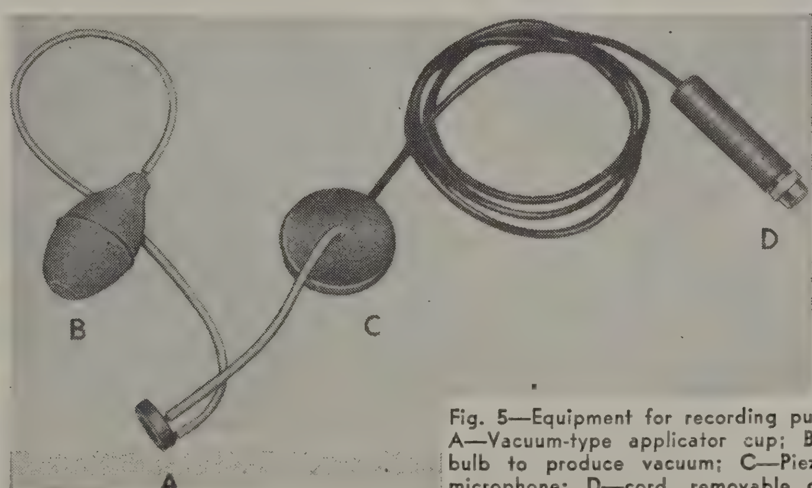


Fig. 5—Equipment for recording pulse beats. A—Vacuum-type applicator cup; B—Rubber bulb to produce vacuum; C—Piezo-electric microphone; D—cord, removable connector.

Instruments set up properly to align a television receiver.

VIDEO Alignment

By ROBERT N. VENDELAND*

NO wide-awake radio serviceman can deny that FM and television have caused a revolution in service techniques. Wide-band, high-frequency amplifiers necessary in television circuits are converting screw-turners into either well-equipped radiomen or ex-radiomen.

Correct alignment of a television or FM receiver is difficult and sometimes impossible without visual alignment equipment. If there is no real trouble in the set, and all it needs is trimming up, it may be possible to use an AM signal generator and a good indicator. But once the radio man has tried a visual alignment, he'll not consider any other method.

The television channel allotted to a single station is 6 mc wide, *almost six times as wide as the entire standard broadcast band.* As a result, all the tricks used to obtain high-gain, selective, broadcast-band amplifiers must be reversed to get video amplifiers to respond to the frequency range necessary for reproduction of a high-quality picture. The obvious solution to the problem of wide-band amplifier adjustment is visual alignment.

Fig. 1 shows a typical response curve for the i.f. amplifier of an AM broadcast set. As the unmodulated signal-generator output frequency rises toward 456 kc, the output of the stage increases. It reaches a maximum at 456 kc and then tapers off as the frequency increases still more. The curve shows just where the output of the stage is maximum. To line up the receiver, the signal generator is set at 456 kc and the trimmers are adjusted for maximum output-meter reading.

In a television receiver, a typical i.f. response curve might look like the one shown in Fig. 2. This is plotted in the same way as the curve in Fig. 1. As the signal-generator output increases in frequency, the i.f.-stage output increases to a maximum at 23 mc and then drops off to a dip at 25 mc. At 27 mc there is another maximum and then a drop to zero at 30 mc.

In aligning a TV i.f., it might seem a simple matter to set the signal generator to 23 mc and tune for a given output, then turn to 27 mc and tune for the same output, with one check for a dip at 25 mc. This may work if the set is not out of alignment, but usually a video i.f. stage employs capacitive overcoupling and adjusting one peak for a maximum affects the frequency of the other peak. If you seesawed back and forth trying to get the proper response, you would soon lose patience.

The visual alignment technique seems to be the only solution. Most servicemen are familiar with oscilloscopes: they have had one on the bench for years and brag about not having had to use the blasted thing once. The 'scope is the business end of visual alignment, and you'll have to splice the line cord back where it was before you borrowed it for the electric fan.

In visual alignment, a sweep signal generator is necessary. This presents to the receiver a signal which varies in frequency from 20 to 30 mc at a 60-cycle rate. In other words, a 60-cycle sine

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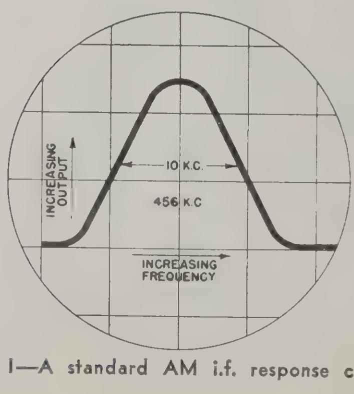


Fig. 1—A standard AM i.f. response curve.

wave modulates the FM oscillator of the signal generator so that at one instant the frequency output is 20 mc and an instant later it is 21 mc, until finally the output increases in frequency to 30 mc. When 30 mc is reached, the signal frequency starts back toward 20 mc. Output at each frequency is maintained at the same amplitude level.

To use the generator and oscilloscope for aligning the video i.f. stages, the output of the sweep generator is first connected to the input of the last picture i.f. Fig. 3 is a block diagram of part of a typical television receiver. C is the point where the oscillator output is first connected.

The 60-cycle voltage which frequency modulates the FM oscillator in the generator is connected also to the horizontal plates of the oscilloscope. This causes the electron beam to pass back and forth horizontally 60 times per second. The vertical plates of the 'scope are connected to the output of the video detector.

Let us assume at first that the i.f. system of this particular receiver is properly adjusted so that Fig. 2 represents the response of the i.f. system at each frequency shown. At the beginning of the sweep, the oscillator frequency is 20 mc. Since the i.f. response at this frequency is very low, the rectified r.f. appearing at the detector will be low. When the oscillator frequency reaches 23 mc, which is one of the peaks in the i.f. response, rectified output of the detector will be high. At each remaining frequency, detector output will correspond to the i.f. response.

Since we have the 'scope connected across the load, the electron beam is moving up and down with the changes in load voltage; and if we can move the beam left and right in exact step with the changing sweep generator output, we'll have drawn our response curve. This is exactly what is done, since the sine-wave voltage that is used to change the FM oscillator frequency is introduced into the horizontal plates of the 'scope.

As the sine wave sweeps to increase the frequency, it also moves the electron beam in the 'scope to the right, and the response curve is drawn exactly as it looks in text books.

Fig. 4 gives a complete graphical picture of the whole operation.

Obviously, a good 'scope is necessary for successful visual alignment. The sweep signal generator should be designed for a sweep-width range that will show more than the entire response curve. For making a television alignment the sweep generator should have at least a 10-mc sweep, for all band widths extend somewhat beyond the 6 mc of a television channel and the trace must taper to a reference line. Fig. 2 shows the trace tapering off to zero at 20 and 30 mc, giving a good picture of the relative amplitudes on a 'scope pattern. If, for example, the generator sweeps a trace as shown in Fig. 2, but only extends from 22 to 28 mc, the curve would show only from A to B, and it would be difficult to see the ratio between the peaks of the curve, point C, and the point of zero response at 20 and 30 mc. On the other hand, if the sweep width is too great—say 50 mc—the response curve would be only a small hill on a long line across the 'scope screen as shown in Fig. 5.

For an FM low-i.f. amplifier alignment, a generator with a sweep width of approximately 450 kc is sufficient. For television alignment, the sweep width must be at least 10 mc, and the center frequency of the sweep should be adjustable from about 5 mc to the top of the television channels (around 215 mc).

After the two basic pieces of equipment—'scope and sweep generator—are properly selected, a marker generator is necessary. When using the Hickok 610 sweep generator which will be discussed in this article, no marker generator is required since the instrument has a built-in marker. The function of the marker generator is to place a mark of some type on the sweep pattern so that you can tell the exact frequency represented by any point on the 'scope pattern.

The marker generator is usually an extremely accurate signal generator. It puts out an r.f. signal which mixes with the sweep signal and places a pip, as shown in Fig. 2, on the response curve. Reading the dial setting on the marker generator tells you the exact frequency of the pip.

Several precautions must be taken or false results may waste time. For visual alignment at high frequencies, the grounding of all equipment is essential. A common ground in the form of a metal plate or a heavy grounding bus is absolutely necessary. If touching any piece of equipment changes the sweep pattern, the grounding is not adequate.

Manufacturer's directions for each receiver being aligned should be followed to the letter, since the correct order for alignment will differ from receiver to receiver.

The block diagram (Fig. 6) shows the Hickok 610 signal generator. Notice the FM generator in the upper left corner. The center frequency of this oscillator is variable from 75 to 115 mc. The 75-mc fixed oscillator shown below it is switched in and out of operation by the range selector on the instrument. The outputs of the two generators are combined in the mixer shown. By using the actual frequency, the sum and difference frequencies, and the first harmonic of

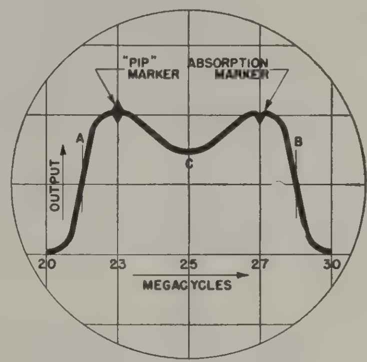


Fig. 2—I.f. response of television receiver.

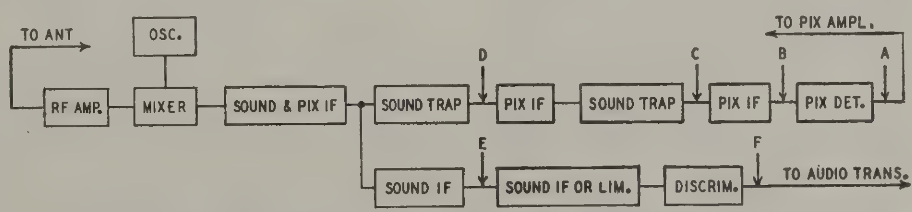


Fig. 3—Instruments are connected to the televiser at points lettered in the diagram.

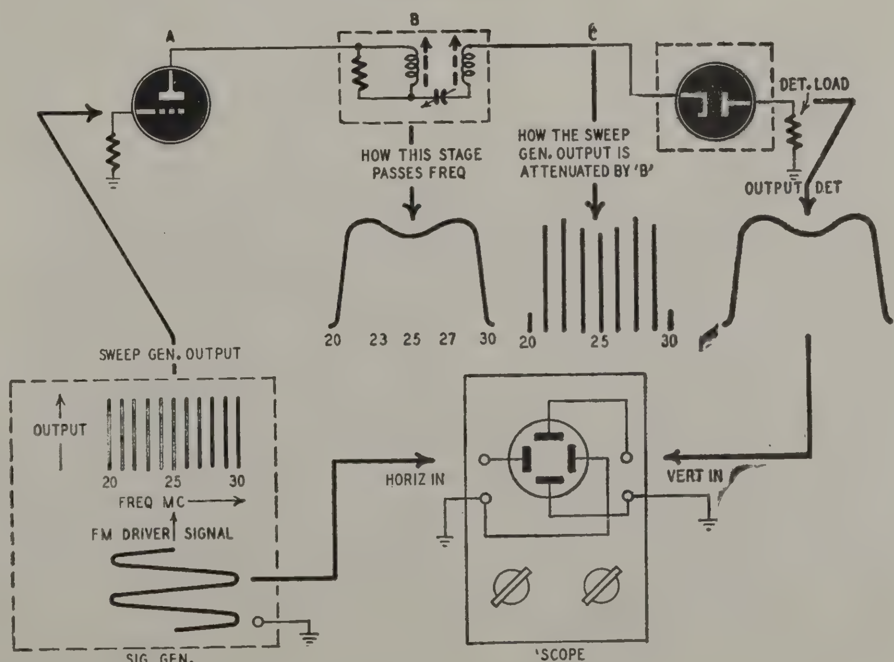


Fig. 4—Shows path of test and synchronizing signals through the set and oscilloscope.

each oscillator, the range of the generator can be extended from zero to 240 mc.

The mixer output is fed to a cathode follower and an attenuator. The other features of the generator shown on the block diagram will be discussed as they are used in the alignment of the typical television receiver of Fig. 3.

The oscilloscope is connected across

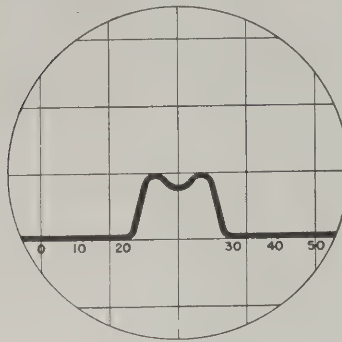


Fig. 5—Result of using too wide a sweep.

the detector load, point A in Fig. 3. Several features of the Hickok 505 'scope adapt it particularly to visual alignment. Its input amplifier has a response up to 1 mc. It is extremely sensitive, and its input can be fed through an internal demodulator for observing sweep patterns before the detector of the set—at point B, for example. The 'scope also has its own 60-cycle sweep with provisions for phasing the retrace or for blanking it out.

For the beginning of the alignment, the sweep generator is fed into the grid of the last picture i.f. amplifier, point C in Fig. 3. The center frequency is set for the middle of the picture i.f. channel, and the sweep is adjusted in width until the entire response is visible on the 'scope screen.

The set manufacturer's data will generally show a picture of the desired response at each stage. The slug adjustments in the cans are tuned until the 'scope picture looks like the manufacturer's response chart for that stage. At first it will probably appear like the one shown in Fig. 7, with the main trace and the retrace out of phase. When the 505 or 195 'scope is used as the indicator, the 60-cycle horizontal-sweep voltage need not be taken from the sweep generator. These 'scopes have internal 60-cycle sweeps with provisions for phasing the forward trace and the retrace so they will coincide to look like Fig. 2. The 505 'scope has a return-trace eliminator so that the retrace can be blanked out entirely, with no need for phasing. However, the 610 generator has a phasing network built into it so that the main trace and the retrace can be made to coincide on any 'scope. If this is employed, the horizontal-sweep voltage from the generator must be used.

The internal marker of the model 610 will check the frequency of each point on the trace. This built-in, variable-frequency oscillator has a dial with extremely accurate calibration from 20 to 30 mc, the range of most television i.f. channels. The dial is calibrated in tenths of a megacycle to eliminate all guesswork. The amplitude of the marker signal is variable, but always use the minimum necessary output. Too large a marker amplitude will distort the response curve.

Occasionally, the i.f. amplifiers will pick up stray oscillation and several markers may appear on the trace. To aid in identifying the proper marker, the 610 has provision for stopping oscillation of the marker oscillator and using the tank circuit as a wave trap in the sweep output. This will put an absorption dip in the response pattern as shown in Fig. 2. Some servicemen prefer this to the pip and use it in all cases.

After the stage before the detector is aligned, manufacturer's directions usually specify connecting the sweep generator to point D of Fig. 3, the grid of the first picture i.f. amplifier. The 'scope lead is left at the detector grid. The trap just before point C is aligned. This usually is an adjacent-channel trap used to eliminate the sound from a lower channel. Correct adjustment is made when the trap frequency shows a minimum on the indicator. Shut off the sweep and use the marker generator as a source for the trap frequency. For a better indication on the 'scope, the built-in, 400-cycle modulator shown in Fig. 6 can be turned on. Tune the trap for minimum amplitude.

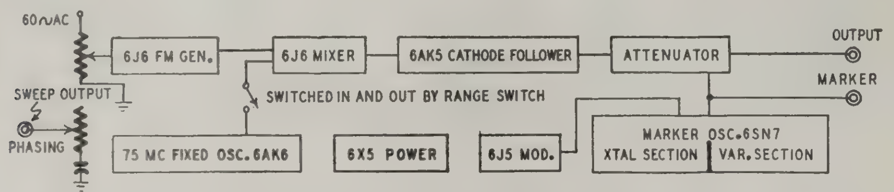


Fig. 6—Block diagram of Hickok 610 generator used in the alignment method described here.

Turning on the sweep causes the next response pattern to appear on the 'scope. This procedure is repeated stage by stage until the antenna input is reached. During the earlier part of the alignment, the manufacturer may have advised disabling the oscillator. When the signal is fed to the antenna terminals, the oscillator should be connected. The response curve of the whole set will appear on the 'scope screen.

Before the oscillator is tuned, the sound channel is usually aligned. Since the sound channel is an FM receiver, it can be adjusted just like any separate FM radio. The only difference is that in most cases the sound channel of a TV set has a 20- to 30-mc i.f., while an FM receiver i.f. is usually in the 10-mc range. For visual alignment of television FM circuits, the model 610 sweep generator is ideal; but for FM receivers, the lower-frequency sweeps of the Hickok model 288X FM-AM signal generator or similar units give better results. The 505 'scope has a built-in FM sweep that is excellent for lower-frequency work.

In aligning a sound channel visually, the discriminator or ratio detector is aligned first. The curve is adjusted to show a response like that in Fig. 8. Marker frequencies are injected in the same manner as for picture-channel alignment. If an extremely accurate marker is desired, the built-in Pierce crystal oscillator of the 610 generator may be employed. This oscillator may be modulated or unmodulated and is injected in the same manner as the variable oscillator.

To align for the pattern of Fig. 8, the sweep generator is inserted at the second sound i.f. or limiter grid (point E in Fig. 3), and the 'scope is connected to the discriminator load (point F). After the discriminator response curve is obtained with markers at the correct points, the generator output is moved back stage by stage, always giving a larger discriminator response curve on the 'scope. To bring the over-amplified picture back within the bounds of the 'scope screen, decrease generator output. This makes sure that no saturation of the stage under alignment is occurring.

Correct tuning for i.f. amplifiers is obtained when the discriminator response is at a maximum and shows no distortion.

After both picture and sound i.f. amplifiers have been adjusted, the oscillator for each channel may be tuned. This is of particular importance on push-button or turret-tuned sets where each channel has its private tuning arrangement. Crystals whose harmonics fall on the desired channel's sound frequency may be used to set up each television station. These crystals may be obtained for the sound carrier frequency of any of the 13 channels.

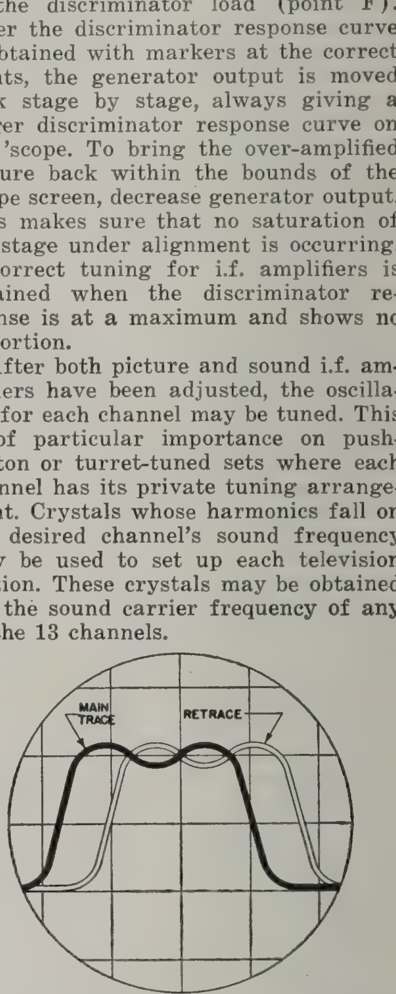


Fig. 7—Trace and retrace curves not phased.

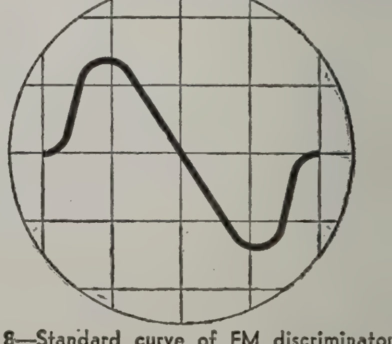


Fig. 8—Standard curve of FM discriminator

French Television Progress is Rapid

By P. HEMARDINQUER*

THE number of television receivers in France is still very small—it does not exceed a few thousand. This is so, first, because there is only one television broadcast station in France; and second, because of the very high price of television receivers. Programs are not particularly exciting, and the station is on the air not more than one hour daily.

This limited program schedule—due to budget economics of the French government—does not prevent the engineers of France from continuing their research, and some remarkable results have already been obtained. American technicians declared that the 1,000-line transmissions they saw were better than American television.

Projection television is also being studied, and in the near future a double television projector (analogous to the double motion-picture projector) will be installed in a Paris movie house to televise both films and news items.

The new projector consists of a television receiver, the projection equipment itself, a control panel, and a power supply.

To maintain uninterrupted projection under all circumstances, the installation is made in duplicate. Two complete sets of equipment are ready to operate at all times; if one should stop, the other can be swung into immediate action. (See Fig. 1.)

A special cathode-ray tube of high power is used for projection. It is shown with its optical system in Fig. 2. The accelerating voltage can be regulated between 60 and 80 kilovolts.

The electronic beam has an intensity of 2 ma maximum and an average of 0.5 ma. The tubes are very powerful—the dimensions of the primary image to be projected are 12 x 16 cm (about 4.7 x 6.3 inches) and the diameter of the luminous spot is only 0.25 mm.

The screen is of the directive type, having either a powdered-aluminum-covered flat surface, or a slightly concave surface covered with little plates of stamped aluminum to form a concave mirror. This assures a good concentration of reflected light along the vertical plane, while maintaining sufficient horizontal diffusion. The gain obtained, as compared with a white, perfectly-diffusing screen, is 4.25.

The objective lens used has an aperture of f1.9. The brilliance of the projected images is about equivalent to that of a standard motion picture.

As can be seen in Fig. 2, the electron beam is at an angle to the perpendicular of the screen. This makes necessary a correction of the sweep to avoid distortion. A parabolic sweep of the same frequency as the original transmission is utilized for this correction.

The double high-frequency receiver is of the t.r.f. type. It transmits amplified signals at the carrier frequency of 46 mc to the detector and video amplifier stages in the sealed and insulated case through an insulated coupling system sealed in a vacuum tube, as illustrated in Fig. 3.

It is usually convenient to connect the fluorescent screen and an anode of a television tube to ground. The cathode and video amplifier are therefore at a high voltage, approximately 70,000 volts from ground. These elements are in a case mounted on insulators within the body of the projector. (See Fig. 4.)

In view of the great acceleration of the electron beam, and the consequent difficulty of deviating the electrons, the sweep amplifiers have to be particularly powerful.

The equipment will shortly be put into operation to demonstrate to the Parisian public the practical possibilities of large-screen projection in theaters. It is being developed by the *Compagnie pour la Fabrication des Compteurs*, under the direction of the great French television technician, Barthelemy.

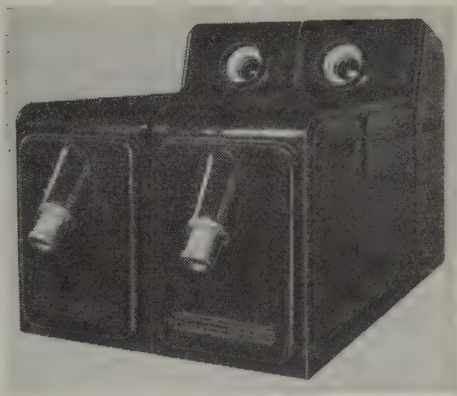


Fig. 1—Dual theater-type TV projectors.

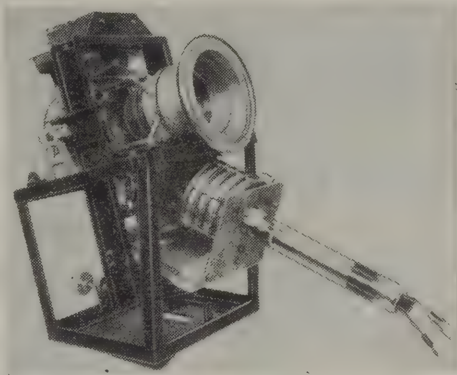


Fig. 2—Optical system of the projectors.

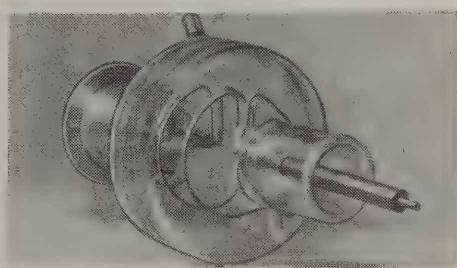


Fig. 3—The insulated r.f. coupling system.

Fig. 4—Side view of the projector with cover removed to show arrangement of the components.

*Consulting Engineer, Grenoble, France

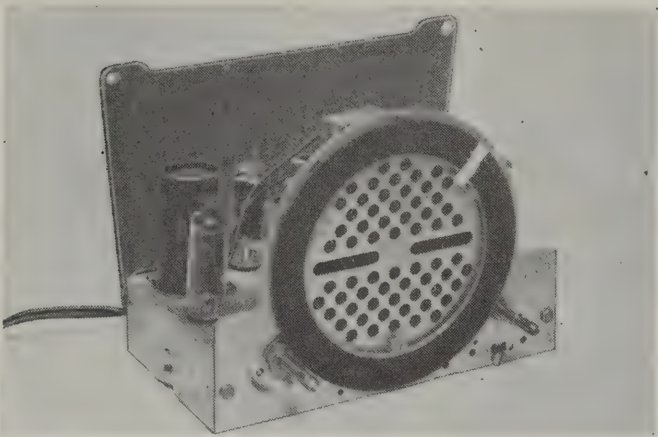


Fig. 1—The dial pointer is on the ring in front of the speaker.

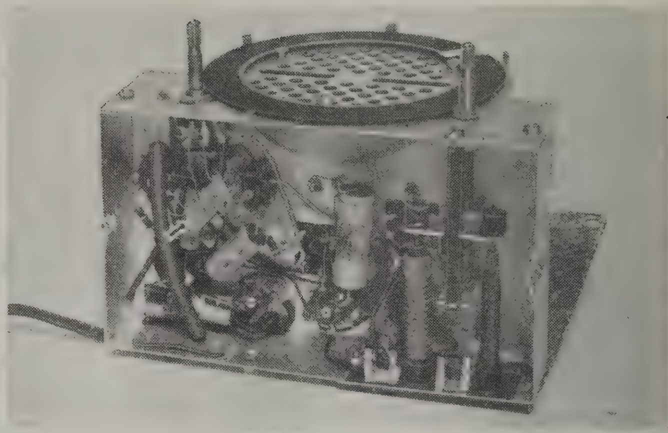


Fig. 2—Arrow points to plate containing four printed capacitors.

Radio Set and Service Review

Ward's Airline Models 74BR-2003A and 84BR-1515A

RESTRINGING receiver dial drive mechanisms quickly and correctly has meant headaches and loss in time and profits to radio service technicians for years. All too frequently, manufacturers fail to supply dial stringing data in their servicing information. Even when dial stringing guides are available, the average technician finds it almost impossible to replace the dial string without four hands, Scotch tape and an assortment of hooks, needles and other gadgets.

This problem has been eliminated in the Model 84BR-1515A and 74BR-2003A Airline receivers developed by the Belmont Radio Corporation for Montgomery Ward. The former model is shown in Figs. 1 and 2. This is a 4-tube-plus-rectifier a.c.-d.c. broadcast set with permeability tuning. The tuning control shaft, on the right in the photographs, has a small gear linking it to the 5-inch dial gear mounted around the circumference of the speaker. A ¼-inch metal pointer fastened to this ring or gear is visible through a slot under the calibrated scale on the front of the cabinet. Six and one quarter turns of the control shaft are required to tune across the band.

The end of the tuning shaft projecting under the chassis is threaded and moves the tuning slugs or cores in the antenna and oscillator coil forms as it turns. The back cover of the set is a sheet of metal-backed cardboard used as an antenna for local reception. A Fahnestock clip fastened to, but insulated from, the cover provides capacitive coupling to an outside antenna.

An interesting innovation in receiver construction is the use of printed circuits. The coupling and bypass capacitors enclosed in broken lines between the 12AT6 and 50B5, Fig. 3, are on a thin ceramic plate ½-inch long and 1 inch wide. This unit is indicated by the arrow on Fig. 2.

The Model 74BR-2003A, Figs. 4, 5 and 6 uses a new type of slide-rule construction for dial drive. The pointer is fastened to a strip of spring brass with serrations on one edge (like a hacksaw blade) to engage the teeth of a small gear on the tuning control. The strip slides in the channel of a flat guide very much like the cross section of a flat curtain rod. The saw-tooth serrations are visible on the metal strip in the close up view at left of Fig. 4.

This set was designed as a radio-phonograph combination. Its circuit, Fig. 6 is similar to the circuit of the 84BR-1515A in Fig. 3. This set uses a loop antenna mounted in the cabinet and connected to the chassis through a socket and plug connector. Speaker and phono pickup connect to the chassis through co-axial type connectors.

When the chassis is in the set it is 3 inches high over-all. This makes it possible to install it in a cabinet just a few inches higher than the over-all depth of its record player or changer.

The electrical specifications of these sets are given below. Sensitivity measurements are based on 50 milliwatts output. This may be measured by disconnecting the voice coil and replacing it with a 3.2-ohm, 5-watt resistor. A level of 0.4 volts a.c. across the resistor is equivalent to 50 milliwatts.

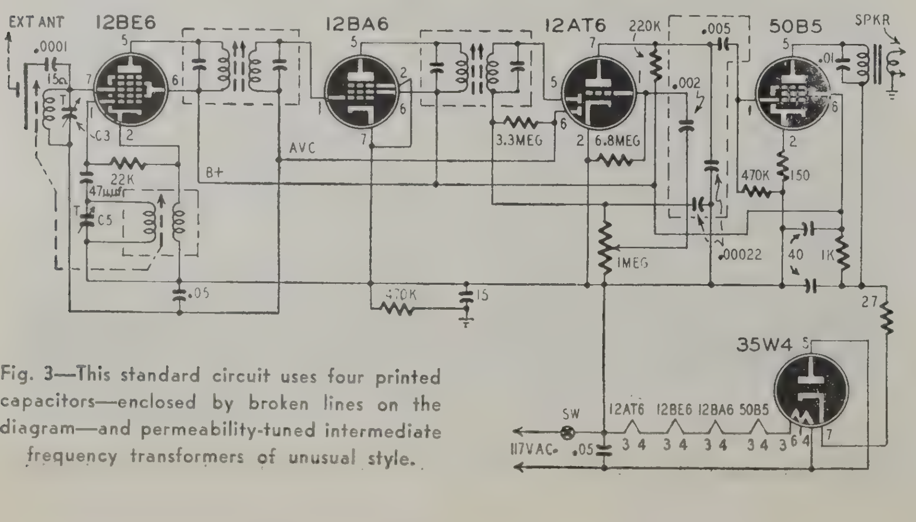
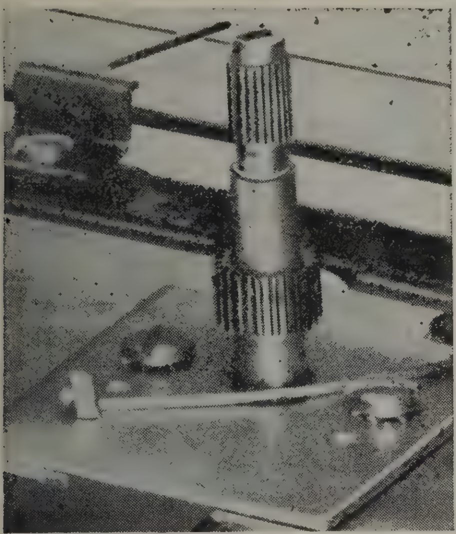


Fig. 3—This standard circuit uses four printed capacitors—enclosed by broken lines on the diagram—and permeability-tuned intermediate frequency transformers of unusual style.

Model 74BR-2003A

Power supply—105 to 125 volts a.c. or d.c., 35 watts.
Frequency range—535 to 1620 kc.
Intermediate frequency—455 kc.
Selectivity—At 1,000 kc. 50 kc at 1,000 times down.
Sensitivity—10 microvolts average for 50 milliwatts output.



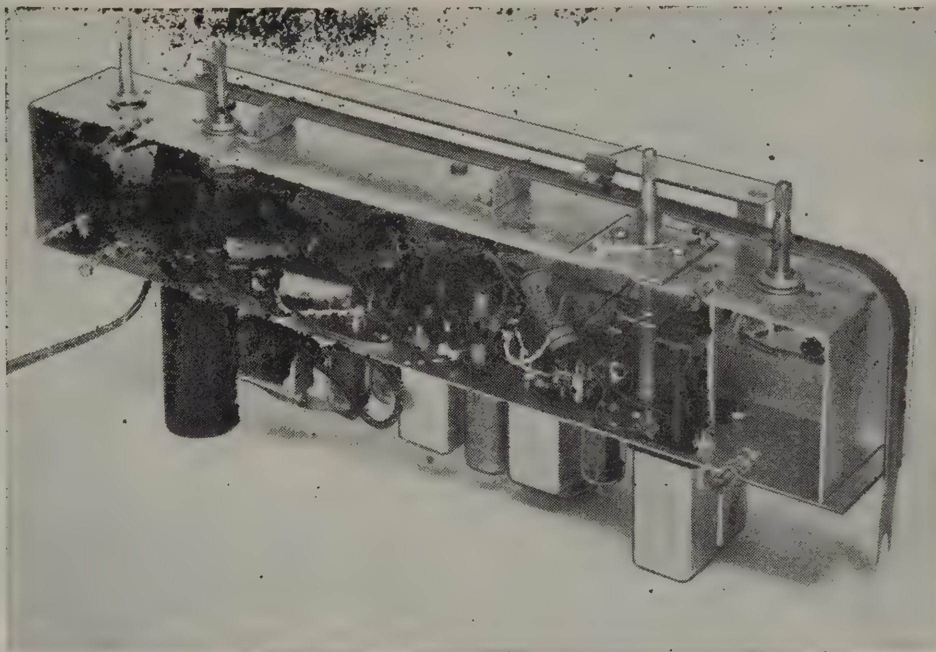


Fig. 4 (Right)—Bottom view of the 74BR-2003A shows the flexible-rule dial drive system. An enlarged view of the dial drive is shown above.

Power output—0.75 watt undistorted, 1 watt maximum.
Loudspeaker—4 x 6-inch oval PM with 3.2-ohm voice-coil impedance.
Tube complement—12BE6 converter, 12BA6 i.f. amplifier; 12AT6 detector; a.v.c.; and a.f. amplifier, 50B5 power amplifier and 35W4 rectifier.
Automatic record changer.

Model 84BR-1515A

Power supply—105 to 125 volts a.c. or d.c., 35 watts.
Frequency range—535 to 1620 kc.
Intermediate frequency—455 kc.
Selectivity—At 1,000 kc, 55 kc at 1,000 times down.
Sensitivity—20 microvolts average for 50 milliwatts output.
Power output—0.7 watt undistorted, 1 watt maximum.
Loudspeaker—4-inch PM, 3.2-ohm voice coil impedance.
Tube complement—12BE6 converter, 12BA6 i.f. amplifier, 12AT6 detector; a.v.c. and a.f. amplifier, 50B5 power amplifier and 35W4 rectifier.

Alignment procedure

The signal generator used for aligning these sets should be modulated 30 percent with a 400-cycle a.f. signal. The a.f. signal must be available for a.f. measurements. Alignment data for the 84BR-1515A and 74BR-2003A will be found in Tables I and II respectively. When checking tracking of either set at 1400 kc, screw the antenna core in or out for maximum volume. Retune the set to 1620 kc and check C3. If no appreciable change is needed the tracking is good. If C3 requires considerable adjustment, readjust the setting of the antenna core. Make these two adjustments several times until C3 does not have to be readjusted at 1620 kc.

If the tuning slugs of the 74BR-2003A are badly out of alignment or the set fails to track properly, turn the tuning control until the bracket holding the slugs is against the front of the chassis. Adjust both tuning slugs so they protrude 1 9/32 inch out of the base of the

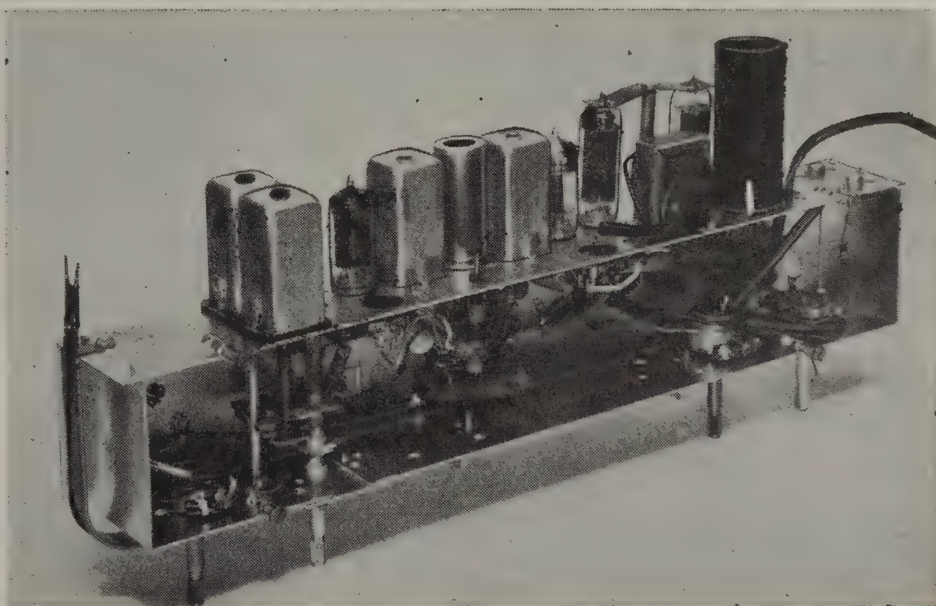


Fig. 5—This view shows the bottom and rear of the chassis used in the Model 74BR-2003A.

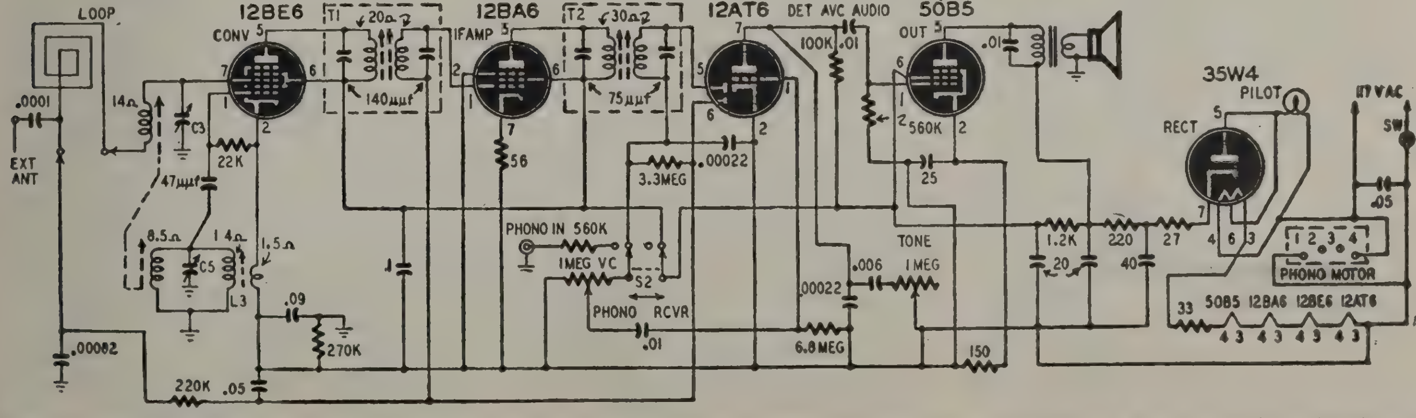


Fig. 6—Special oscillator coils simplify tracking in the 74BR-2003A. The chassis is 3 inches high, 15⅜ inches long and 6½ inches deep.

tuning assembly. If trouble is had with the 84BR-1515A, adjust the slugs to the positions shown in Fig. 7.

The i.f. transformers in these sets are

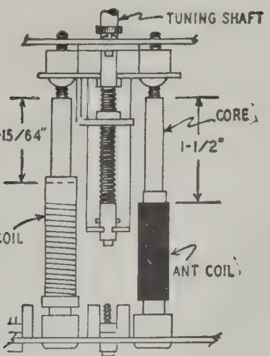


Fig. 7—Permeability tuner of the 84BR-1515A.

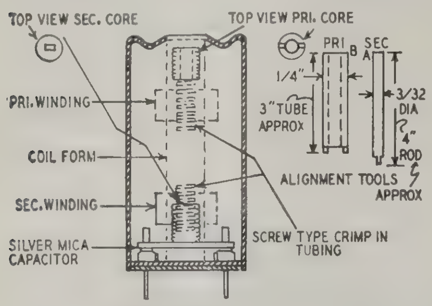


Fig. 8—Cross-section of the i.f. transformers.

of novel construction. The primary and secondary windings are on the same core with all tuning adjustments made from the top. A cross-section drawing of these transformers is shown in Fig. 8. The core of the primary winding has a hole through its center to allow a special tool to pass through for adjusting the secondary core. The primary and secondary tuning tools are A and B shown at the upper right in Fig. 8. Both are made from fiber or other insulating material. In use, the secondary tool passes through the center of the primary tool.

Two resonant peaks will be noticed when adjusting the i.f. transformers. Be sure that the primary core is *above* its coil and the secondary core is *below* its coil.

TABLE I
84BR-1515A

SIGNAL GENERATOR						
Frequency	Coupling Capacitor	Connection to Radio	Ground Connection	Tuner Setting	Adjust For Maximum Output	Input For 50-Milliwatt Output
455 kc	.1 μf	12BE6, Pin 7	12AT6, Pin 2	Iron cores all the way out	Cores in output and input i.f. cans	45 microvolts
1620 kc	.1 μf	12BE6, Pin 7	12AT6, Pin 2	Iron cores all the way out	Oscillator trimmer C5	———
1620 kc	2 μμf (max. capacity)	External antenna clip	12AT6, Pin 2	1620 kc	Antenna trimmer C3	20 microvolts
1400 kc	2 μμf (max. capacity)	External antenna clip	12AT6, Pin 2	1400 kc	Adjust position of ant. core by screwing in or out	20 microvolts
400 cycles	.1 μf	12AT6, Pin 1	12AT6, Pin 2	———	———	.03 volt

TABLE II
74BR-2003A

SIGNAL GENERATOR						
Frequency	Coupling Capacitor	Connection to Radio	Ground Connection	Tuner Setting	Adjust For Maximum Output	Input For 50-Milliwatt Output
455 kc	.1 μf	12BE6, Pin 7	12AT6, Pin 2	Iron cores all the way out	Trimmers on output and input i.f. cans	28 microvolts
1620 kc	.1 μf	12BE6, Pin 7	12AT6, Pin 2	Iron cores all the way out	Oscillator trimmer C5	———
535 kc	200 μμf	External antenna clip	12AT6, Pin 2	Iron cores all the way in	Shunt osc. coil L3	11 microvolts
1620 kc	200 μμf	External antenna clip	12AT6, Pin 2	1620 kc	Antenna trimmer C3	8 microvolts
1400 kc	200 μμf	External antenna clip	12AT6, Pin 2	1400 kc	Adjust position of ant. core by screwing in or out	8 microvolts
400 cycles	.1 μf	12AT6, Pin 1	12AT6, Pin 2	———	———	.03 volt

Regulating Voltage With VR Tubes

Amateur and constructor will find them valuable in a number of applications

By RICHARD L. PARMENTER

IN the modern ham station the need for stabilized voltages in various electronic circuits is becoming more and more apparent. When the circuit requiring voltage regulation draws a relatively small current, gaseous type regulator tubes carry out this function very well. They are economical and simple to install, requiring only the tube and socket and one or two resistors. Since they present few difficulties to the user, these tubes should be used more than they have been in the past. This description of some of the uses for VR tubes is a reminder that such a useful little gadget is available to the radio builder.

The VR tube will be a big help to the beginner who has built a regenerative detector receiver and who has been disconcerted by the tendency of this type receiver to be thrown "off-tune" by variations in plate voltage caused by line voltage fluctuations. They are practically indispensable to the more experienced builder who has need for stable voltages in frequency meters, variable-frequency oscillators, and local oscillators of v.h.f. receivers. Since these tubes maintain a relatively constant voltage across a varying load and stabilize a varying supply voltage across a constant load, their many uses are apparent.

When a voltage of correct potential is placed between two terminals in air or any other gas, the gas will break down suddenly and act as a reasonably good conductor of electric current. This breakdown is because a high enough voltage actually tears electrons from the molecules of the gas and under these conditions a large number of positively charged ions and negatively charged electrons are produced. The breakdown point is determined by the amount of

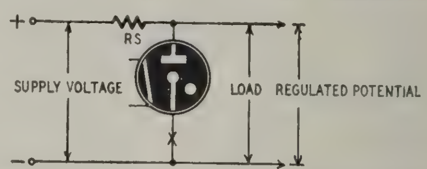


Fig. 1—This is the basic regulator circuit.

voltage together with the amount of gas in the tube and also its pressure. It is fairly easy to understand that the less dense the atmosphere inside the tube, the less difficulty the electrons will have in their progress from cathode to plate. Under reduced pressure the ionization

voltage—the voltage at which the tube will conduct—may be reduced. The operation of neon tubes, mercury vapor tubes and gaseous regulator tubes is based on this fact. The starting voltage of regulator tubes is about 30% higher than the rated voltage of the tube. Once the gas has become ionized voltage changes at the plate of the tube result in changes

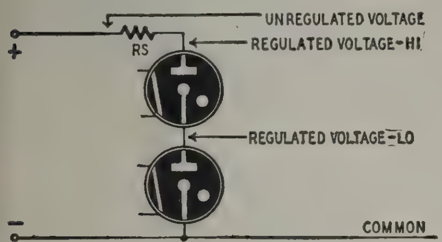


Fig. 2—Two tubes give two regulated outputs.

in the amount of current it passes. This condition exists until the potential at the plate is reduced to a certain critical value when the tube will revert to its original state of passing practically no current.

In the case of all VR tubes—when ionized—the change of current through the tube due to variations in potential results in a certain constant potential across the tube. In this respect the tube is acting like a constantly varying resistor which has a lower value if the potential is high and a higher value if the voltage is low. In this way, the effective IR drop across the tube is kept at a constant value. This constant IR drop is applied across the load, which thus receives a practically unvarying supply.

The basic circuit for the use of VR tubes is shown in Fig. 1. The supply voltage must be approximately 30% greater than the voltage that is desired.

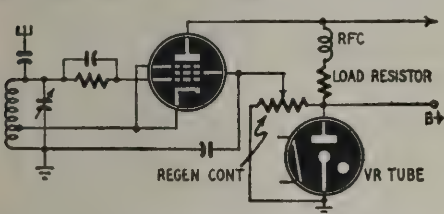


Fig. 3—A stabilized regenerative detector.

This is because a higher potential must be applied to the tube to ionize it. As soon as the tube is conducting the output voltage drops to the rated value of the tube. In the OD3/VR150 a starting potential of about 185 volts is desirable for good regulation. The series resistor RS is of correct value to hold the current through the tube to a value of somewhere between 15 to 20 milliamperes for normal operation, depending upon the application. If the total potential available from the power supply closely approaches the voltage rating of the tube, the regulation will be poor and will be effective only over a limited range. In other words it is desirable to have the tube conducting a considerable amount of current to start with so that a greater range may be covered by its variable resistor characteristics. If the resistor RS is less than 3,000 ohms to make the tube draw about 20 ma, then the supply voltage is too low for the particular VR tube being used. Use Ohm's law to determine the value of resistor RS, after the supply voltage has been measured. In the following formula, the necessary series resistance RS is equal to the voltage to be dropped across the resistor divided by the current which is to pass through it. Thus

$$RS = \frac{Es - Er}{I}$$

where

RS is the value of limiting resistor
Es is the supply voltage
Er is the regulated voltage (tube rating)
I is the maximum rated current of the tube in amperes. Usually about .03 amp.

The voltage Es–Er is the amount that is lost by IR drop across resistor RS.

If two or more VR tubes are connected in series, then two regulated potentials may be obtained as shown in Fig. 2. The value of the limiting resistor in this case would be determined in the same manner as before but the total value of regulated voltage (add ratings of the

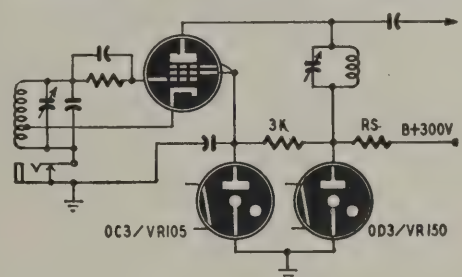


Fig. 4—VR tube adds to v.f.o.'s stability.

tubes used) would be used for Er. By connecting two or more tubes in series it is possible to obtain a wide range of voltages suitable for various uses. Remember, however, that the total amount of current that can be drawn from the bottom tube, Fig. 2, of the series string is limited because the upper tubes must carry all the current in the circuit. The upper tube or the one that is nearest the B-plus would have to carry its own current (10 to 30 ma) plus the current of the lower tubes, plus the current that is drawn off for the load. In other words, the current that is available for the load must necessarily be quite small, perhaps 10 ma or less, in order to leave enough for the voltage regulating function of the tubes. This is one of the limitations of VR tubes but this may be partially offset by designing the load so little current is required for it. Along the same line of thought of course, is the fact that quite often the circuit design may be such that 150 volts maximum is sufficient for the regulated section.

Typical VR-tube applications are shown in Figs. 3, 4 and 5. Since these are merely representative circuits, exact values for the various components are not given. Fig. 1 is the basic circuit and the general design procedure has been given for it. The same principles apply to any circuit using VR tubes. The resistor RS would be determined mathematically and checked for correct value by noting if the tube "starts" when voltage is applied. If no glow appears around the electrodes of the tube, either the supply is not high enough or the value of resistor RS is too high. Insert a 0-50 ma d.c. millimeter at X in Fig. 1 and adjust RS until 20 to 25 ma flows in the circuit. Since this current will drop with increased load, it is better to set the no-load current somewhat higher than would normally be assumed. Even as high as 30 ma is desirable in some cases.

The regenerative detector circuit Fig. 3 uses an OD3/VR150 for regulating the d.c. voltage to compensate for variations in line voltage. An electron-coupled detector is shown but others could be used if preferable. To provide screen and plate voltage regulation, use the same setup as in the v.f.o. circuit, Fig. 4. In this diagram, both screen and plate voltages are regulated for variations in load. This is desirable in a variable-frequency oscillator since some variation in load and output will be noted when tuning across its frequency range. Regulated voltages are necessary in this type of oscillator to maintain good frequency stability and reset accuracy.

Fig. 5 shows a grid-dip oscillator used widely for determining frequency of resonant circuits in transmitters and receivers. It works on the principle that if power is absorbed from an oscillating circuit (by another resonant circuit in this case) the current flowing in the grid circuit will decrease sharply. In other words if a tuned circuit of the same frequency as the tuned circuit of the oscillator is brought near it, the point of resonance of the unknown circuit will be indicated by a sharp dip in the rectified grid current. Unknown L-C combinations may be calibrated by this means. Since grid-dip oscillators are calibrated with the best standards available, good plate voltage regulation is desirable to maintain their accuracy to the highest degree. The VR tube fits into the requirements very nicely. In fact, the only other way to obtain satisfactory operation is to use a battery supply.

These few illustrations of the various uses of VR tubes should indicate to the radio builder or experimenter many other possibilities for their effective use. In almost all radio or electronic equipment there is often a compromise between accuracy and cost of equipment. The performance of many pieces of equipment can be improved through good voltage regulation. Since the cost of voltage regulation is low, this is an excellent means of improving the accuracy of test equipment.

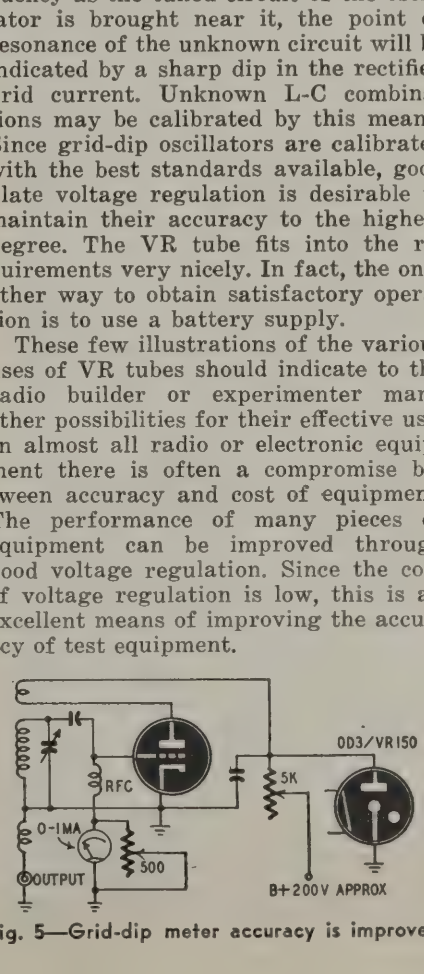
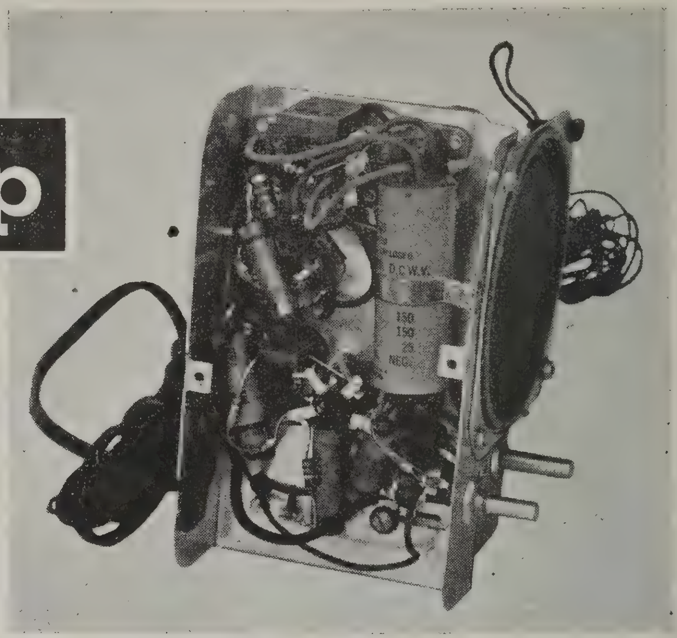


Fig. 5—Grid-dip meter accuracy is improved.

Pepping Up Midgets



A.c.-d.c. midgets often offer many opportunities for improvement.

By K. E. STEWART

SOME midget a.c.-d.c. receivers do not have sufficient sensitivity for use in remote areas where signals are weak. Often a repairman in a vicinity where there are fairly good signals will find a midget receiver which seems to test o.k. in every respect except that it doesn't have enough volume. Although installing an outside antenna will usually improve reception in both these cases, such an antenna is not always convenient.

One common fault in midget receivers is too many turns of wire in the tuned loop antenna. The technician may find, in trying to peak the antenna trimmer around 1500 kc, that the output increases as the trimmer capacitance is reduced. Often the capacitance cannot be reduced enough to hit the resonance peak. Removing 1 to 3 turns of wire from the loop will correct this condition. The turns should be removed from the *inside* of the loop. Only one turn should be removed at a time. Check with the antenna trimmer after removing each turn. The removal of more wire than necessary to provide peaking will reduce the sensitivity of the set.

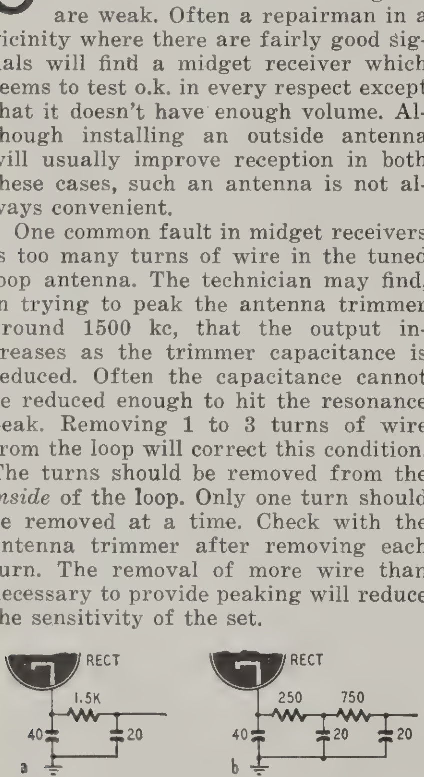


Fig. 1—How to decrease filter resistance.

Another common fault among midgets is the tendency to go into oscillation when tuned to the low-frequency end of the dial if the i.f. trimmers are peaked. On checking the alignment of these receivers it is sometimes found that the i.f. transformers have been slightly stagger-tuned to prevent oscillation, with, of course, a resultant loss of sensitivity. If the feedback producing oscillations is removed, the i.f. transformers can be peaked, giving a marked increase in selectivity as well as sensitivity. Feed-back can often be eliminated by properly dressing the i.f. transformer leads or by removing some of the excess wire. Substituting metal tubes for glass ones will sometimes eliminate the trouble when tube shields fail.

The output stage in many modern midgets does not have a cathode bypass capacitor. The omission of this capacitor introduces some negative feedback into the stage, reducing hum and increasing stability. The bass response and the general output can be increased by the installation of a 10- to 25-µf bypass.

Usually receiver output can be substantially increased by a comparatively small addition to the B-supply voltage.

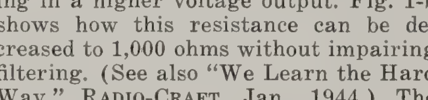


Fig. 2—Typical a.v.c. circuit in midget set.

A typical filter circuit used in these receivers is shown in Fig. 1-a. The filter resistor has a value of 1,500 ohms. If the value of this resistor can be reduced, the IR drop will also be reduced, resulting in a higher voltage output. Fig. 1-b shows how this resistance can be decreased to 1,000 ohms without impairing filtering. (See also "We Learn the Hard Way," RADIO-CRAFT, Jan., 1944.) The 1,500-ohm resistor is replaced with two resistors, one of 250 ohms and the other of 750 ohms. A 20-µf, 150-volt capacitor is also added. The ripple voltage with this circuit is usually lower than it was originally, and output goes up considerably.

In most midgets the a.v.c. filtering circuit consists merely of one resistor and one capacitor, with no isolating networks for the various controlled stages. Fig. 2 shows a typical circuit. Sometimes a noticeable increase in volume will result from replacing the .05-µf capacitor with 0.1 µf unit.

The 3-megohm isolating resistor shown in the figure should be reduced to prevent too great an increase in the a.v.c. time constant. The time constant in seconds is the product of C in µf and R in megohms. The time constant in Fig. 2 is 0.15 second. Therefore, if the capacitor becomes 0.1 µf, the resistor must be 1.5 megohms to hold the time constant to 0.15 second. However, in most cases, a 2.2-megohm resistor will give more output, and the increase in the time constant will not be noticed.

It is important in changing the filter circuit of the a.v.c. to avoid loading the audio output of the detector to any appreciable degree. Effectively, the resistor and the capacitor are in series across the audio load. The 0.1-µf capacitor, if placed across the audio load, would constitute practically a short circuit. The series resistor prevents this and therefore must be kept fairly high in value.

In a few stubborn cases it is worth while to reduce the a.v.c. voltage to get more gain in the receiver. A practical way to do this is shown in Fig. 3. A 470,000-ohm resistor is connected between the load end of the a.v.c. line and ground. This value is usually best for the proper compromise between added gain and reduced a.v.c. action.

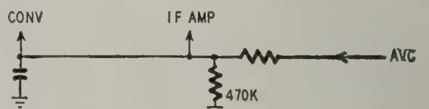


Fig. 3—How the a.v.c. voltage can be reduced.

Most of these methods are of course contrary to the manufacturer's design of the receiver. They are recommended only as a last resort after the set has been thoroughly checked for ordinary faults. The manufacturer generally expends more time and labor in engineering his receiver than you will be able to, and it is bad business to redesign a circuit while overlooking faults which may continue to get worse.

European Report

By Major Ralph W. Hallows

RADIO-CRAFT LONDON CORRESPONDENT

TELEVISION is now going ahead rapidly in France. At the moment the only transmitter is installed in the Eiffel Tower in Paris; but relays at Lille and Lyons are now under construction and are expected to be in operation before long. Other relaying stations are to be built at Bordeaux, Toulouse and Marseilles. It has been decided that the present 455-line system shall be maintained for at *least 10 years* to insure purchasers of televisers against having their sets made obsolete overnight by changes in television standards. At the same time an 819-line service is being developed to work side by side with the other. The Eiffel Tower station already has two 819-line outfits, including orthicon-type cameras, which are being used for experimental transmissions. Several important demonstrations have been given with complete success. The same program was sent simultaneously by 455-line and 819-line transmitters. At the receiving end corresponding televisers were arranged side by side so the audience could make direct comparisons between the high-standard and definition systems. During these demonstrations a series of linens, cretonnes and other cloths in a variety of intricate designs and colors were placed in front of the cameras. A friend who saw one of the shows tells me that reception of patterns such as fine black and white checks was startlingly good. "I hadn't a notion that television could do such things," said he! Another interesting item was the projection on to a 12 x 10 feet screen of a film made from 819-line television images.

You must know about the system invented a good many years ago, which allows movie film to be exposed, developed, fixed and passed through a projector in well under 30 seconds. It may be that a combination of this system with 819-line (or, perhaps, one thousand-and-something-else line) television will provide the quickest short-cut to big-screen television—though I can't and won't believe that it's anything like a final solution of the problem.

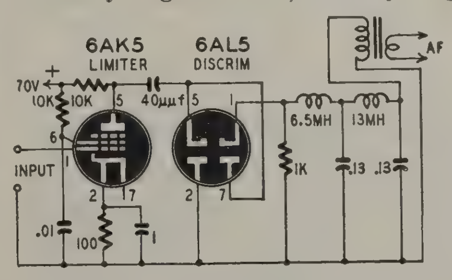
AM versus FM

In Britain the experts are getting heated up almost to the assault-and-battery point over the relative merits of AM and FM for v.h.f. high-fidelity broadcasting. Almost any place where radio hams gather you will find such heated arguments that you begin to wonder when the shooting will start. The AM fans maintain that the method of their choice can do anything that can be done by FM. They protest that FM means receivers of a more elaborate and expensive type and that cheap FM sets can never do justice to this type of broadcasting. Frequency drift, they say, would damn the cheap receiver and the difficulty of tuning such a set would result in further damning on the part of its owner.

On the other hand the FM supporters (of whom I am most emphatically one, provided that no one with more than about my 190 pounds of weight looks like getting nasty) hold that FM gives by far the better all-around results; that it is much superior in eliminating man-made static (the only kind that matters much at such frequencies); that it is a disgrace to designers in these days for even a cheap set to suffer from frequency drift; and that both alignment and tuning can be made perfectly simple. Who will win the battle? Clothing is strictly rationed and laundries play havoc with what we have; but I'd bet my shirt—even if it was the last one I had—on FM.

Stable discriminator

Talking of FM alignment leads me to mention a remarkably stable discriminator circuit (shown below) described recently by Thomas Roddam in *Wireless World*. Roddam is one of our most brilliant young radiomen, and anything



he writes about is worth studying. His discriminator circuit is shown in the accompanying diagram. It is not, as he says, very efficient; it needs a high input and delivers a low output; but it *does* stay put. It requires a 150 kc intermediate frequency, though that raises no great difficulty. The point about it, as the author says, is that it goes on working indefinitely and just can't go wrong. All the constants are given in the diagram so that readers who care to experiment with the circuit can make it up and see for themselves what sort of goods it delivers.

French televisers

At the recent *Foire de Paris* (Paris Fair) an unexpectedly large number of French-made televisers was on display. No less than 23 makers exhibited them and the number of different types was considerable. Till recently few televisers have been available in France with cathode-ray tubes of larger than 7 to 9 inches—and there weren't very many of those. At the Fair there were 11 different sets with 12-inch tubes and three of the projection type, with screens ranging from 16 x 12 to 22 x 16 inches. None of the projection types were priced, so they can't be regarded as production models. Of the others, prices ranged from $260 for a 10-tube table-model giving vision only and with a 9-inch screen to $920 for a 25-tube console with a 12-inch screen and incorporating a radio receiver. French designers as a whole seem to favor four main control knobs, though there was one model with only two. Others had from five to eight. It didn't seem as if would-be buyers would have long to wait for delivery. Seven manufacturers guaranteed to supply at once; others mainly offered delivery in one to three weeks. And, believe it or not, that's pretty good going in Europe nowadays. If my tailor doesn't soon let me have the suit of clothes I ordered six months ago, I'll be going about in a blanket!

Wired wireless

I'm not sure whether there are radio program relay services in American towns and villages. By program relay services, I mean systems in which a company runs an elaborate receiving station in or just outside a built-up area and supplies subscribers, connected by wires to a central exchange, with a choice of two or more programs. Wired wireless is used a great deal here. Subscribers pay 35 to 40 cents a week and the relay company provides and maintains the simple gear needed in their homes. The advantages are that the subscriber gets trouble-free and interference-free reception of good quality at all times and in all conditions. The British Post Office, which also runs the country's telephone system, has been engaged for some time in developing a system of relaying radio programs to telephone subscribers. When he wants radio the subscriber calls the exchange and asks for the program of his choice. He then turns a switch which cuts out his telephone and brings in an amplifier and loudspeaker. Should there be a telephone call for him, he receives a warning from the loudspeaker. He then turns the switch to the telephone position and takes the call.

Modern Phono Oscillators

By RICHARD L. PARMENTER

CONSISTING of few parts and only one tube, this little phono oscillator will enable the user to play records through any broadcast radio with no external connections.

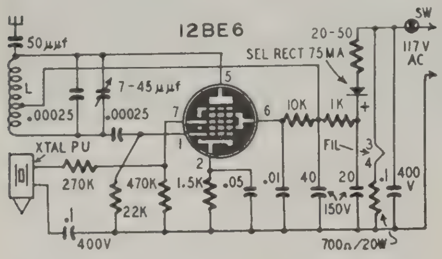


Fig. 1—Schematic of the 1-tube oscillator.

Its small size, only 4½ inches long by 3½ inches high and 2½ inches deep, enables it to be installed in almost any record-changer cabinet in some unused corner. It is simple to construct and after the initial adjustment of tuning to a good spot in the broadcast band it need not be bothered with again.

A 75- or 100-ma selenium rectifier is used for the rectifier. A tube rectifier such as a 35W4 could have been used but the writer believes that the selenium type is a better performer over a long period of time. Also, the output voltage is somewhat higher, resulting in slightly greater power output. This is an advantage since only a short piece of wire need be used for the antenna. 15 inches of wire gave satisfactory results when placed inside the changer cabinet.

The 12BE6 oscillates at some frequency in the broadcast band. Modulation is applied to the No. 3 grid (see Fig. 1.) The output of the average crystal pickup is enough to modulate the r.f. output. The frequency of the oscillator is determined by the coil L, the 250-µµf mica capacitor and its padder, a 7-45-µµf mica variable. The latter should be installed so that it is available for adjustment. The coil L consists of approximately 90 turns of No. 32 enamelled wire on a ⅝-inch-diameter bakelite form. Tap the coil about 33 turns from the grid end.

The chassis used was made from light aluminum. A piece 4 x 4½ inches was bent, resulting in a simple L-shaped base. Cookie sheets make good stock for this. This is ample to house the parts although, as Fig. 2 shows, they are compactly fitted in. The rectifier is mounted on top of the chassis (Fig. 3) to allow for cooling, since this unit dissipates some heat. The coil and tube are also mounted on top. The 7-45 µµf padder condenser is located on the front panel to allow for adjustment. Two banana jacks are used for phono pickup connections. These are mounted on the front as well as the on-off switch.

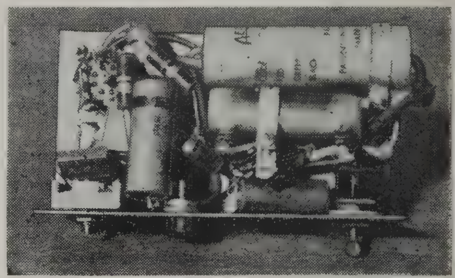


Fig. 2—Parts have to be fitted in carefully.

The wiring of the oscillator is simple. Keep the line and filament wiring away from the circuits of grids 1 and 3 of the tube to minimize hum pickup. Be sure to observe the correct polarity of the selenium rectifier.

To set the oscillator in the broadcast band, first locate the signal. This will be heard in the receiver as a whistle or a rushing sound when no record is being played. It should be somewhere on the low-frequency half of the band with the components used. If the builder finds that some other portion of the band would be better at his location, decrease the size of the 250-µµf mica condenser to 200 µµf or even less. Now pick a spot on the band where there are no strong stations. By adjusting the padder condenser tune the oscillator to this spot. It may be easier to locate the signal from the oscillator by playing a record.

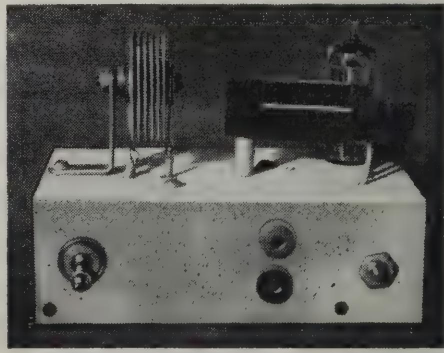
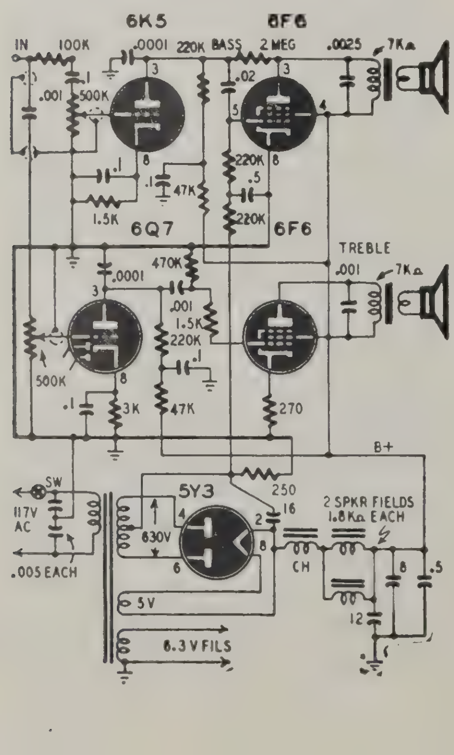


Fig. 3—Rectifier is mounted above chassis.

Two Channels For Hi-Fi

By P. HEMARDINQUER

USING a two-channel amplifier—one channel for the treble and the other for the bass—is one way to obtain a more lifelike sound quality. The diagram of such an amplifier is shown. It was developed in France. Instead of mixing the two channels together in the output, a separate speaker is used for each. The bass speaker is 10 inches in diameter and the treble unit 4 inches.



The input from the phonograph or receiver is fed through a 0.1-µf capacitor to the bass channel and through a .001-µf capacitor to the treble channel. The feedback network in the bass-channel 6F6 (the resistor and capacitor between plate and grid) and the capacitor across the transformer primary help to discriminate against highs. The small coupling capacitors in the treble channel discriminate against lows.

The fields of the two speakers are of the same resistance in this receiver and are connected in parallel as the filter choke.

Tonal balance is adjusted by varying the input potentiometers for both channels.

(Note—It is very likely that special conditions in France have influenced the design of this amplifier. An American constructor would be likely to use at least a 12-inch speaker for the bass, and would probably substitute a 6F5 or the triode section of one of the 6Q-series of tubes for the near-obsolete 6K5. A push-pull output stage would probably be desirable in the bass channel, if not in both. Reversing voice coil connections to one of the speakers will vary the angle of distribution of the high frequencies. *—Editor)*

Instantaneous Intercom

Selenium rectifier and battery tubes eliminate the warm-up time

By HAROLD R. NEWELL

THIS intercom is suitable for home, office or any location where the noise level is not too high. The circuit provides for one master and one remote but can be adapted for several remotes. Each station can call the other.

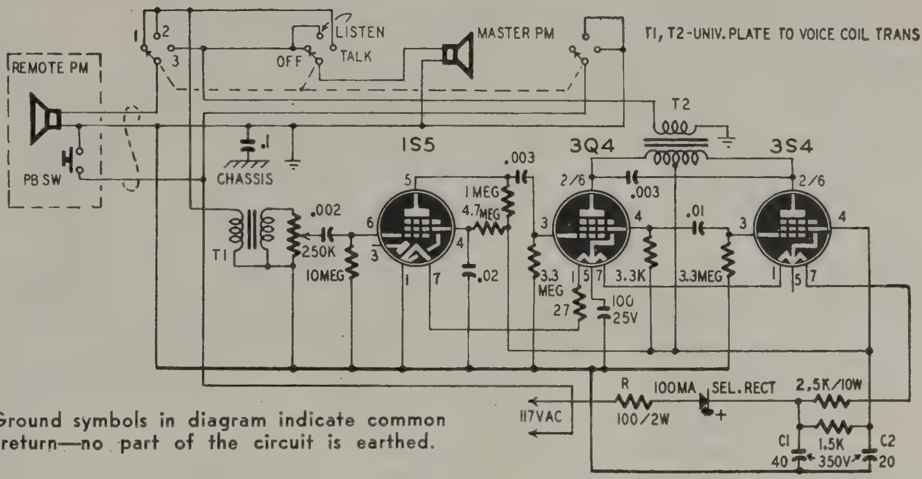
The power is normally turned off. Instant starting is possible because of the selenium rectifier and miniature instant-heating battery-type tubes. There is no standby current and the tubes are being used only when actually needed.

The tube lineup includes a 1S5 as first audio amplifier driving a push-pull output stage using a 3S4 and 3Q4. These two different tubes are used because they match the bias obtainable from the filament circuit. Although they have somewhat different load ratings, they work very well together and provide ample output.

The method of obtaining the phase-inverted signal for the 3S4 is the same as used in several commercial receivers. A resistor is inserted in series with the screen of the 3Q4 and the signal developed across it is passed to the 3S4 through a blocking condenser.

An aluminum chassis 4½ x 4¼ x 1½ inches is used for the master station. On this are mounted a 4-inch speaker, the three tube sockets, two transformers, volume control, switch, and filter-capacitor can. The volume control and the switch are mounted on a bracket at the side of the chassis. The selenium rectifier is mounted below the chassis.

A 2,500-ohm 10-watt resistor is used to drop the voltage for the tube filaments. It is bypassed with the 100-μf section of the condenser block, which includes C1, C2, and C3.



Ground symbols in diagram indicate common return—no part of the circuit is earthed.

The talk-listen switch is a 3-pole, 3-position positive-acting rotary. The first position of the switch is OFF. The remote speaker is connected as a microphone. When the remote power button is pressed, the amplifier is turned on and the remote can call the master. In the second position the master may listen. In the third, the master may talk.

The master and remote units are connected with a three-wire cable. One wire is the circuit ground, the second for the voice coil and the third for the power button. When the power button is pressed to call the master, some hum is produced because the ground wire is common to both the audio and a.c. power circuits.

Although useful in getting the master's attention this hum may be eliminated by using a four-wire cable, with a separate power-return lead.

Note that the circuit ground is separated from the chassis by a 0.1-μf capacitor. Though not necessary electrically, this helps prevent shock and is common practice with transformerless power supplies. To make the unit absolutely safe, the amplifier should be enclosed in a wooden cabinet and all external cables and leads should be well insulated.

The author has not found much use for the volume control; the gain is about right as is. If desired, it may be eliminated.

Some adjustment of R may be necessary to obtain correct voltages at the tube filaments.

UNOBTRUSIVE HEARING AID

One of the reasons many hard-of-hearing people refuse to wear hearing aids is an objection to their conspicuousness. This problem has been largely overcome in recent years by placing the amplifier, microphone, and batteries in one small case which can be hidden in a pocket. However, the earphone is usually quite visible.

A new type of receiver developed by the Maico Company reduces the visibility of the earphone almost to zero. Instead of plugging the phone directly into the ear, it is pinned to the inside of a man's collar or concealed in some part of a woman's clothing or hair. A small chain is attached to it for this purpose. (See photograph.)

Secreteer compared in size with finger ring.

A thin lucite tube fastened to the receiver conducts the sound to a moulded plastic insert shaped to fit inside the ear. The insert is almost invisible when it is in place, not only because it is made of flesh-colored plastic but also because it is exactly shaped to the contours of the ear.

Despite the acoustical transmission through the lucite tube the quality of the sound appears to be unaffected. Listening tests on the Secreteer have proved it very satisfactory.

The amplifier measures about 4¾ x 2½ inches. The batteries and microphone are in the same white plastic case.

Three Bug-Free Amplifiers

The author presents circuits and data for three straightforward amplifiers

By JOHN W. STRAEDE*

IN this article descriptions of three straightforward bug-free amplifiers are given. Their circuits are comparatively simple and do not include unnecessary parts. They deliver 9, 13 and 20 watts respectively.

The tubes used in the amplifier of Figs. 1 and 2 are a couple of voltage-amplifying pentodes in cascade followed by a 6L6-G developing 9 watts. The rectifier is either a 5Y3-G or 5V4-G depending upon the voltage of the transformer secondary. If the high-voltage winding gives about 375 volts per side a 5Y3-G (or an 80) can be used. If the voltage is lower, around 300 per side, the more efficient 5V4-G must be used to provide a sufficiently high d.c. output. As an alternative to the 5V4-G, a metal 5Z4 can be employed.

Parallel mixers are used with 270,000-ohm isolating resistors between the volume controls and the control grid of the second tube.

Unusual points in the circuit are the use of grid leak bias on the first 6J7, lack of a filter choke, use of a volume-expander lamp and a lamp as fuse.

Advantages of grid leak bias are the saving of a cathode resistor and a bypass condenser and lower hum level (because cathode is grounded.)

No filter choke is necessary for ordinary PA use, because a beam tetrode or pentode output valve has a high plate resistance and the plate current is almost entirely unaffected by changes in plate voltage.

The pilot lamp connected across the voice coil winding of the speaker transformer gives a small amount of automatic volume expansion but its real use is to act as an output-level indicator.

Another 6-volt 0.3-amp lamp is connected in the negative side of the high-voltage supply to prevent damage to the power transformer if an electrolytic condenser should break down. The pilot light may have to be omitted if a 5V4-G or other low-impedance rectifier is used, because switching the set on and off when hot may cause the lamp to blow out.

One feature not at first noticeable is the way in which the circuit is designed to give a good frequency response. Although there are small plate bypass condensers to remove any r.f. that may be picked up, the plate load resistors are smaller than usual, resulting in an excellent high-frequency response. Bass response is also good because the decoupling network for the 6L6-G bias supply acts to a certain extent as a bass-booster.

A conventional high-cut tone control is connected between the plate of the second tube and ground.

A 47,000-ohm suppressor resistor is connected directly in series with the 6L6-G control grid to make the sound more tolerable when momentary overloads occur.

To eliminate the bass boost, reduce C to .01-μf and increase the suppressor resistor R to 270,000 ohms.

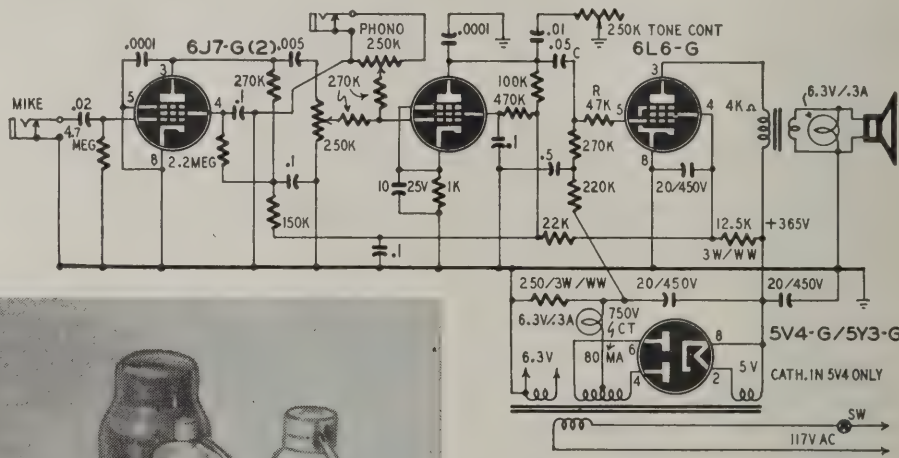
The sixth pin of each tube socket (except the rectifier) is used as a tie point. It is definitely not advisable to have parts rigidly mounted—a little slack in the wiring gives elasticity and minimizes the chances for resistors and condensers to break down.

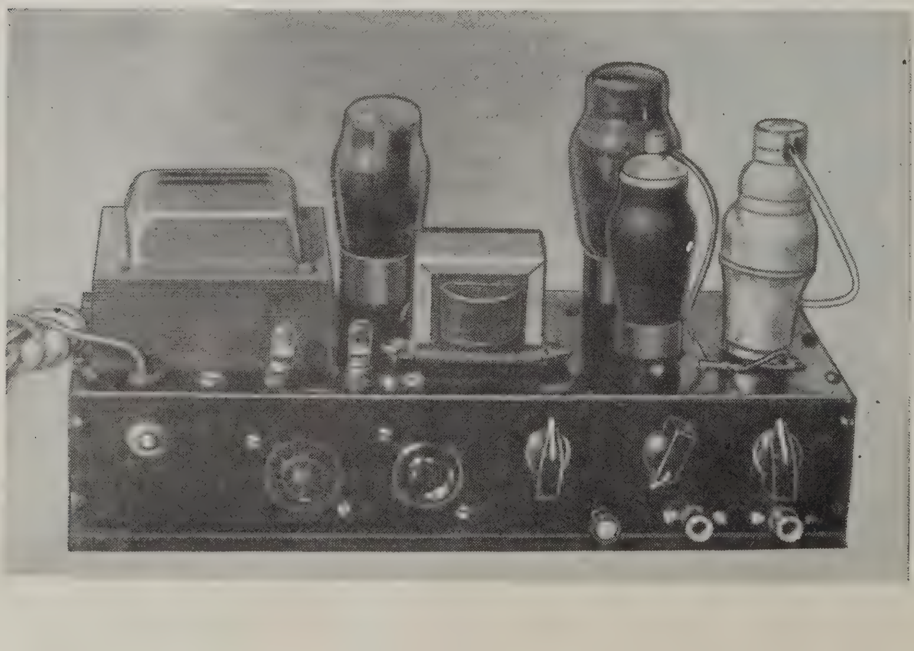
Six tubes, thirteen watts

The second amplifier (Figs. 3 and 4) is quite orthodox, bearing some similarity to the smaller job in the use of shorting jacks, high-cut tone control and lack of a filter choke.

*Lecturer in electronics and electro-acoustics, Melbourne Technical College, Australia.

Fig. 1 (right)—Schematic of the 9-watt unit. Fig. 2 (below)—Sockets are for speaker plugs.





A pair of 6V6-G beam tetrodes is used in class AB1. The operating conditions are such as to provide negative regulation (the total current drawn decreases at full volume).

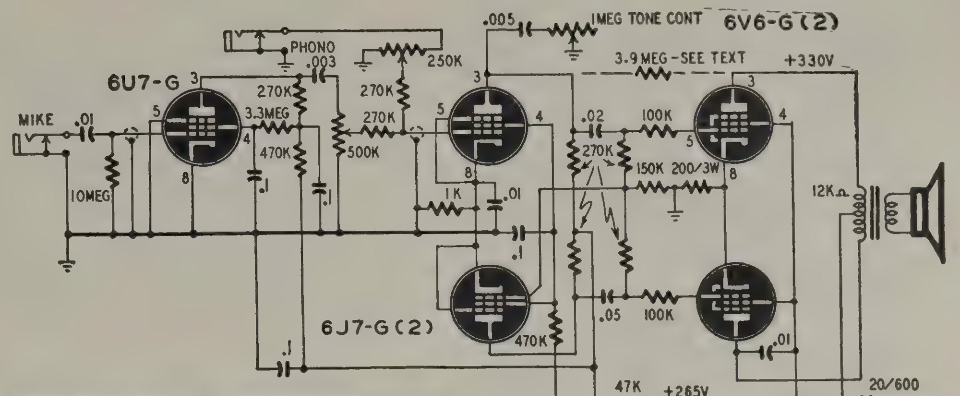
Floating paraphase phase inversion is used—a system which gives an automatic near-balance. This system cannot give perfect balance, for if each 6V6-G grid had an equal signal, there would be no signal to drive the phase-inverter grid.

The common cathode resistor helps to bring the system nearer to perfect balance—these resistors have such an effect that if the 150,000-ohm resistor is shorted the drop in volume is negligible.

A 20 percent change in value has no perceptible effect. Most critical value is that of the 6,500-ohm dropping resistor for the 6V6-G screens. If no wire-wound resistor is available three 20,000-ohm, 1-watt carbon resistors can be connected in parallel.

Although a 3.9-megohm resistor is shown as an inverse feedback device, this is seldom used, as the presence of inverse feedback is apt to cause a rise in hum level when the output tubes do not have a well-filtered supply. (Feedback from the voice coil is less likely to produce a higher hum level but it is not easily applied in this circuit).

Decoupling is used for every stage. The filtering is comparatively poor for the output stage but is better for each preceding stage. The very best of filtering is necessary for the first tube because it is followed by a gain of something like 2,000.



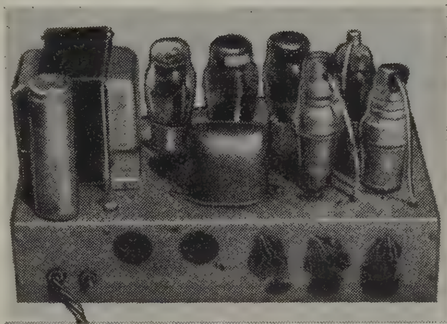


Fig. 3 (above)—The 6-tube, 13-watt amplifier.
Fig. 4 (left)—Chassis layout of this unit.

Five tubes, twenty watts

This five-tube amplifier has a peculiar layout as Fig. 5 indicates. The power-pack section is spaced well away from the four amplifying tubes. This is to allow it to fit in a case with plenty of room in the center for a heavy-duty PM speaker. As in the previous amplifiers, grid-leak bias is used for the microphone preamplifier, but unlike the others, a filter choke is included so plenty of negative feedback can be used without excessive hum. The schematic appears in Fig. 6.

There are two negative feedback circuits. One is from an output tube plate to a 6SC7 plate. The other comes from the other 6L6-G plate to the 6SC7 input grid, helping to compensate for lack of coupling between halves of the output transformer primary.

Paraphase inversion is used and the 6SC7 works very well. Formerly a 6N7 was used, resulting in lower gain.

The cathode of the phase inverter is bypassed for high frequencies with a .05-µf condenser so that there is no common coupling at high frequencies. This allows more effective operation of the high-frequency tone control. The plate-to-plate feedback circuit is connected as a low-frequency tone control.

In the other feedback circuit there are two condensers. One of 500 µµf shunts some signal to ground to reduce the feedback at high frequencies and thus provide a high-frequency boost. The .001-µf condenser in series, provides a bass boost by reducing the feedback at low frequencies.

The gain from 6SC7 grid to 6L6-G anode is about 800 so the feedback voltage is reduced by two voltage dividers—one consisting of 3.9-megohm and 47,000-ohm resistors, and the other consisting of a 1-megohm resistor and the 270,000-ohm isolating resistors of the two volume controls.

If the amplifier is unstable because of too much gain or due to phase changes in the feedback circuit, it may be necessary to reduce the size of the 47,000-ohm resistor or to increase the 1-megohm resistor to around 4 megohms.

Two features not found in either of the other amplifiers are the use of an r.f. suppressor, a 10,000 ohm resistor in series with the grid of the 6J7-G, and the application of a positive voltage to the heaters of the tubes to reduce heater emission, a common cause of hum.

This amplifier is very suitable for recording.

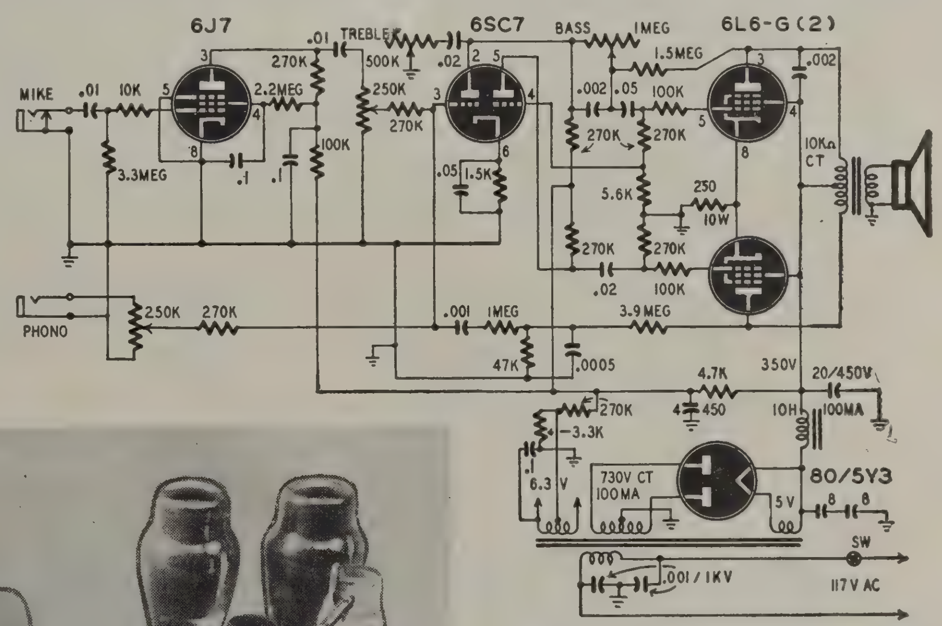


Fig. 5 (below)—Parts placement reduces hum.
Fig. 6 (right)—Amplifier output is 20 watts.

The A. C. Ammeter Saves Testing Time

By JOHN MELICHAREK

The ammeter mounted in the back of the bench.

FEW radio technicians realize the amount of time and labor that can be saved by using an a.c. ammeter in radio servicing. A.c. ammeter ranges are seldom included in multitesters; however, it will be worth your while to purchase a 0-1-ampere a.c. meter for your shop. If you use it intelligently, you can often save hours that would otherwise be spent in tracking down false clues. I use one to check every set that comes into my shop.

I have a 7-inch 1-ampere meter in series with one side of the power receptacle to which I connect all sets for their initial testing. Most sets have the normal power consumption, in watts, marked on a plate or tag on the chassis or cabinet. I convert this wattage rating to amperes ($I = W/E$) and compare it with the reading on the meter. When the reading is higher or lower than normal, it can be used as an indication of possible sources of trouble.

Two troubles are common in radio receivers. A component burns out or opens or develops a short. Your servicing job becomes much simpler when you know which of these conditions exists. The facts are clearly defined for you by the a.c. ammeter. Just plug in the receiver, turn on the power and read the trouble on the meter.

To clarify this, consider a 75-watt receiver that is working properly. Removing the rectifier tube drops the reading to 45 watts (.38 amperes). Pull out the power amplifier tube and the reading drops to 55 watts. A burned-out output transformer or burned-out field coil drops the consumption to 60 or 50 watts. Five-watt drops are easily seen on the meter. Drops of 15, 20 and 30 watts can easily be diagnosed with just a little experience. If the drop were only 5 or 6 watts, you would not need to check or suspect the speaker field, choke coil or rectifier tube.

Like other test instruments, the meter will not show you everything. A 6K7 tube with an open heater will cause about a 5-watt drop; but an open plate or screen supply will not show on the meter. It takes at least 20 ma at 100 volts to give a good indication.

If the radio has a high-current short the meter immediately shows it. Shorted filters and bypass condensers are the two main offenders. Readings will be from 80 to 200 watts. Shorted filter condensers show up almost instantly, while shorted plate and screen bypass condensers do not show up until the filters are charged.

When servicing a.c.-d.c. receivers, the ammeter shows the continuity of the filament string and the current drawn while the set is heating up. An a.c. receiver, when first turned on, draws only about one half of its rated current; the current begins to increase as the tubes reach operating temperature.

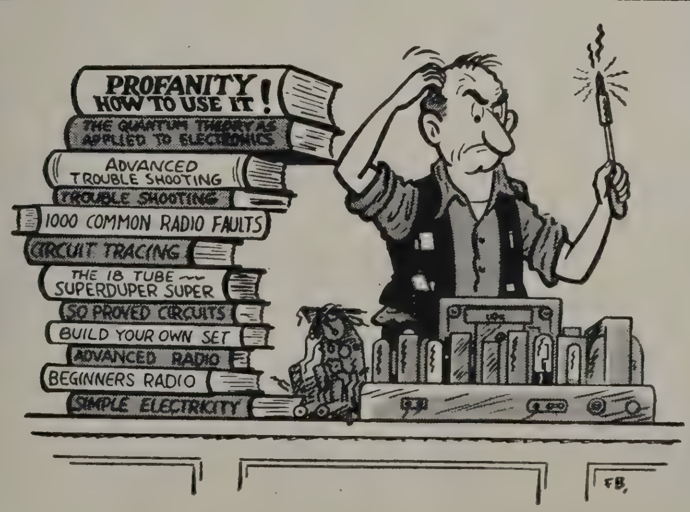
A 40-watt a.c.-d.c. receiver draws only 22 watts when it is first turned on. The current begins to rise as the tubes heat up, and if nothing is shorted, the needle will stop around the 40-watt mark. If it should continue beyond the 40-watt mark a short is indicated and the power should be cut off immediately. Almost any short in the filter section will cause the 40-watt receiver to draw 100 watts. This shows why a rectifier tube can burn out or go bad in a few minutes.

The important point is to watch the meter needle with one hand on the power switch. Be ready to cut off the power if the needle goes beyond its mark for a normal set. The needle may take from 10 to 30 seconds to come to rest. A longer period may be caused by high resistance in the filament string or poor rectifier tubes. If the rectifier is bad (not burned out) the needle will not move off its starting point—a sure indication of what is wrong.

The meter shown in the picture is a G.I. souvenir that I brought back from Germany. It is a French 1-ampere meter, with a 7-inch scale. A meter this size is preferred because the divisions will be around 3 times larger than for a 4-inch meter. It can easily be read from a distance. Still, I would settle for a 2-inch meter rather than none at all.

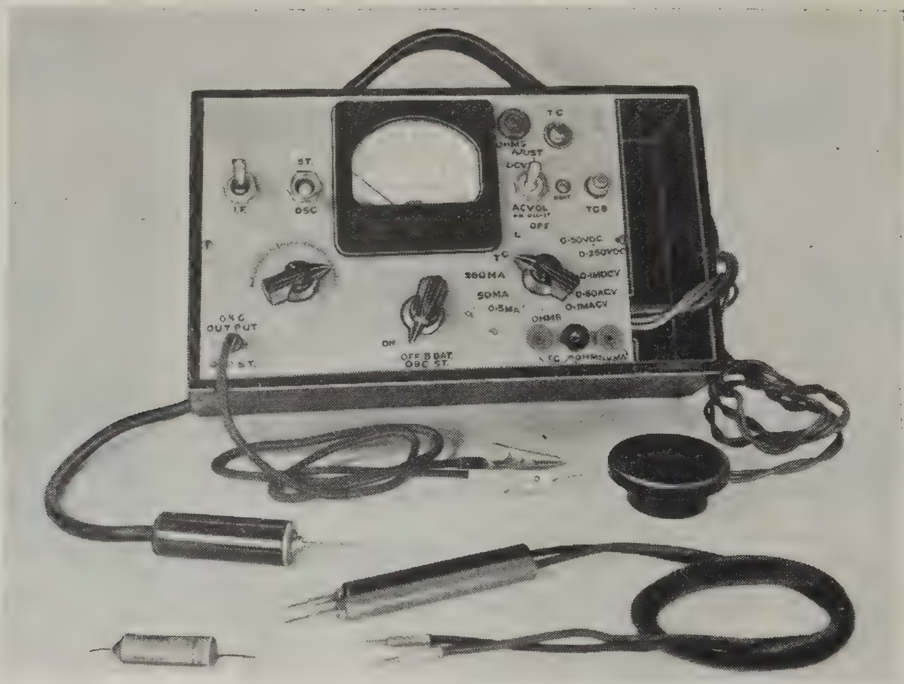
The most important feature of the meter is its range. 1 ampere is about equal to 115 watts. This will take care of most receivers up to 12 tubes (less phono motor). A 2- or 3-ampere meter will not be sensitive enough, unless you are servicing electronic equipment which draws 1.5 amperes or more.

Many radios develop serious shorts which will cause 2 or 3 amperes to be drawn in some cases even more. Always protect your instrument with the proper fuse; for a 1-ampere meter, use a 1-ampere fuse.



Suggested by E. R. Donohue, Walla Walla, Wash.

Steps in the education of a Radio Man.



This small test instrument is ideal for outside service calls. All parts fit into the case.

This instrument has a novel condenser checker plus signal generator-tracer & multimeter

By V. A. JEANNOT

Versatile Tester Has New Features

THIS is an ideal test instrument for experimenters and for radio servicemen to use on outside servicing calls. It is a combination test oscillator, signal tracer, condenser tester, multimeter and continuity and polarity tester. It is inexpensive and can be built into a case 7½ x 5 x 3 inches. A case this size includes ample space for a few replacement condensers, resistors, fuses and other essential accessories.

The condenser tester (for testing paper and mica condensers for shorts) is novel. The basic circuit is shown in Fig. 1. The condenser is placed in a high-frequency high-voltage circuit in series with a neon lamp. One electrode of the lamp glows as the condenser charges and the other glows as it discharges. This action is so rapid that both elements appear to glow at the same time. If the condenser is shorted, only one plate will glow. (Carry several good condensers in the spare parts compartment and shunt them across condensers suspected to be open.)

The high-frequency voltage for the test is developed in a vibrator transformer made from a small relay. The original coil is removed and replaced with a 150-turn primary of No. 24 enamel wire. This is covered with a layer of Scotch tape and the remaining space filled with as many turns as possible of No. 30 enamel wire. The relay contacts are wired so the unit will work as a vibrator or buzzer. When the pushbutton switch S4 (marked TCS on the front panel) is pressed, a high-voltage high-frequency current is developed in the secondary of the vibrator-transformer. The secondary is connected to pin jacks marked T-C through S5B when it is in position 11.

Test Oscillator

The test oscillator or signal generator is a Hartley oscillator using the pentode section of a 1S5. This is shown on the complete diagram, Fig. 2. Two coils are used to cover the i.f. and broadcast ranges with a small 365-μμf variable condenser. The low-frequency coil has 500 turns of No. 30 enamel wire scramble-wound on a ⅜-inch form and the broadcast coil 60 turns of No. 28 enamel wire on a ¾-inch form. Both coils are center-tapped. The low-frequency coil may be the secondary of an i.f. transformer designed to work into a full-wave detector. This coil is mounted inside one end of the large coil form. Coils are selected by a d.p.d.t. switch, S3. The 1S5 is also used in the signal tracer circuit; when using the oscillator S2, a d.p.d.t. switch, should be in the Osc position. Filament voltage is turned on with S1 in the A.C. Vol position. B-voltage, from a hearing-aid-type B-battery, is applied through a switch on the r.f. output control. Output is obtained through an open-circuit jack on the panel. A shielded output cable carries the signal to external circuits. The shield is used as a common return. No modulator is used. The values of the grid leak and condenser—1 megohm and .001 μf—are selected to cause audio blocking or squegging at an audio rate

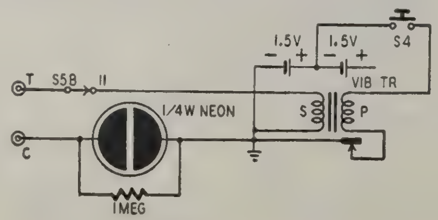


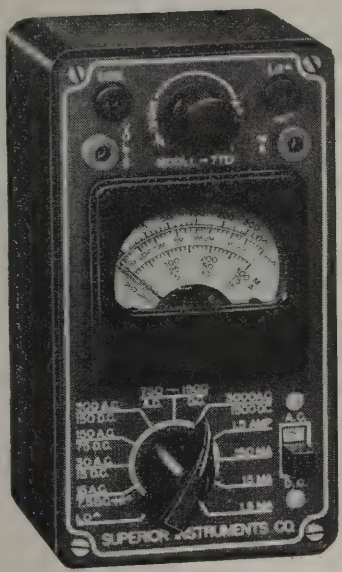
Fig. 1—The condenser checker is unusual.

(Continued on page 48)

AN ACCURATE POCKET SIZE

VOLT-OHM MILLIAMETER

(SENSITIVITY: 1000 OHMS PER VOLT)



The Model 770 comes complete with self-contained batteries, test leads and all operating instructions.

FEATURES

- ★ Compact-measures $3\frac{1}{8}'' \times 5\frac{7}{8}'' \times 2\frac{1}{4}''$.
- ★ Uses latest design 2% accurate 1 Mil. D'Arsonval type meter.
- ★ Same zero adjustment holds for both resistance ranges. It is not necessary to readjust when switching from one resistance range to another. This is an important time-saving feature never before included in a V.O.M. in this price range.
- ★ Housed in round-cornered, molded case.
- ★ Beautiful black etched panel. Depressed letters filled with permanent white, insures long-life even with constant use.

SPECIFICATIONS

6 A.C. VOLTAGE RANGES:
0-15/30/150/300/1500/3000 VOLTS

6 D.C. VOLTAGE RANGES:
0-7.5/15/75/150/750/1500 VOLTS

4 D.C. CURRENT RANGES:
0-1.5/15/150 MA 0-1.5 AMPS.

2 RESISTANCE RANGES:
0-500 OHMS 0-1 MEGOHM

$13.90 NET

RADIO TUBES - STANDARD BRANDS - BULK

All brand new, cartons supplied free with each tube

OZ4	$.65	6H6GT	.49	12SF5GT	.49	24A	.54
1A5GT	.59	6J5GT	.49	12SF7GT	.69	26	.49
1A7GT	.59	6J6	.85	12SJ7GT	.49	27	.54
1H5GT	.59	6J7GT	.55	12SK7GT	.49	35/51	.59
1N5GT	.59	6K6GT	.49	12SQ7GT	.49	36	.74
1LA4	.95	6K7GT	.55	12SR7GT	.49	37	.49
1LA6	.95	6L6G	.95	14A7	.69	38	.59
1LB4	.95	6Q7GT	.55	14B6	.69	39/44	.54
1LC6	.95	6SA7GT	.49	14Q7	.69	41	.59
1LD5	.95	6SC7	.55	25A6G	1.15	42	.69
1LE3	.95	6SF5GT	.59	25L6GT	.59	43	.59
1LH4	.95	6SH7	.55	25Z5	.55	45	.59
1LN5	.95	6SJ7GT	.49	25Z6GT	.47	46	.74
1Q5GT	.95	6SK7GT	.49	32L7GT	.95	47	.74
1R5	.79	6SL7GT	.74	35A5	.65	49	.95
1S4	.69	6SN7GT	.59	35B5	.65	50	.95
1S5	.65	6SQ7GT	.49	35L6GT	.55	53	.74
1T4	.65	6V6GT	.69	35W4	.45	55	.74
3Q4	.69	6X5GT	.65	35Y4	.69	56	.59
3Q5	.69	7A8GT	.79	35Z3	.84	57	.65
3S4	.69	7B7GT	.79	35Z5GT	.45	58	.74
5U4G	.59	7C5	.79	50A5	.85	59	.95
5V4G	.85	7C6	.79	50B5	.55	71A	.74
5Y3GT	.42	7F7	.79	50L6GT	.55	75	.59
5Y4GT	.55	7Y4	.79	50Y6GT	.74	76	.49
6A7	.59	12A8GT	.75	70L7GT	.95	77	.49
6A8GT	.59	12AT6	.49	117L7GT	1.15	78	.49
6AC7	.85	12AU6	.75	117P7GT	1.15	79	.85
6AK5	.75	12BA6	.49	117Z3	.95	80	.42
6AL5	.85	12BE6	.49	117Z6GT	.95	81	1.55
6C4	.42	12J5GT	.49			82	1.15
6C6	.49	12J7GT	.69	TELEVISION		83	.64
6D6	.49	12K7GT	.74	Kinescopes		84	.69
6F5GT	.49	12Q7GT	.74	7EP4	17.40	85	.59
6F6GT	.49	12SA7GT	.49	10BP4	34.50	89	.69

GUARANTEED QUALITY TUBULAR CONDENSERS

An example of the value we offer, the 20/20 150 V condenser listed below (made for us by a nationally famous manufacturer) lists at $1.30, our selling price is only 26c.

		PER HUNDRED
.001	600V	$3.95
.002	600V	3.95
.003	600V	4.40
.005	600V	4.40
.006	600V	4.40
.01	600V	4.40
.02	600V	4.95
.03	600V	4.95
.05	600V	4.95
.1	600V	7.20
		EACH
.25	600V	.12
.5	600V	.17
5	25V	.14
10	25V	.16
25	25V	.18
10	50V	.22
100	25V	.29
16	150V	.18
20	150V	.24
20/20	150V	.26
30	150V	.28
40/20/20	150V–25V	.44
40/40/20	150V–25V	.44
50/30	150V	.44
4	450V	.24
8	450V	.27
16	450V	.36
16/16	450V	.59
20	450V	.39
30	450V	.47
40	450V	.59
80	450V	.97
.005	1700V	.13
.008	1700V	.15
.01	1700V	.17
.02	1700V	.19
.05	1700V	.21
.05	2500V	.58
.1	2500V	.64
.25	2500V	.86
.05	3000V	.69
.003	5000V	.57
.005	5000V	.62
.01	5000V	.74
.0005	7500V	.58
.003	7500V	.67
.0005	10000V	.64

BROOKS RADIO DIST. CORP., 80 VESEY ST., (Dept. A) NEW YORK 7, N. Y.

(Continued from page 46)

The modulation note is about 250 cycles.

The meter we used has a 500-μa (0.5-ma) movement. We removed its scale and replaced it with a multitester scale of the type available from well-stocked radio parts stores and mail-order houses. The internal resistance of the meter was unknown so it was determined by experiment.

The meter was connected in series with a 1½-volt battery and a 5,000-ohm wire-wound potentiometer. The resistance was reduced until the meter read full scale. We then shunted the meter terminals with short lengths of copper or manganin wire until the meter read *half scale*. The resistance of the shunt was measured with a borrowed ohmmeter. The resistance of the shunt is equal to the resistance of the meter. With the meter resistance known, shunts for the various ranges were computed from the formula:

$$R_{shunt} = R_m/N - 1$$

where R_m is the meter resistance and N is the factor by which the basic meter range is to be multiplied. The basic range is 500 μa so the multiplication factors (N) are 10, 100, and 500 for the 5-, 50-, and 250-ma ranges respectively.

Voltage multipliers are designed to limit the current to the basic range of the meter when full-range voltage is applied. The resistance is equal to the voltage range divided by full-scale current (.0005 ampere). Be sure to subtract the meter resistance from the resultant.

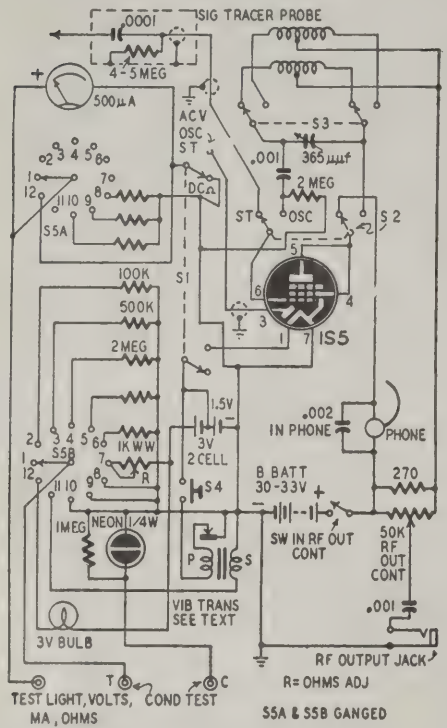


Fig. 2—The complete diagram of the tester. S1 is "up" for a.c. volts, oscillator and signal tracer and "down" for d.c. volts and ohms.

Signal Tracer

As a signal tracer, apply plate and filament voltages and throw S2 to ST. This connects the grid of the tube to the probe and the plate to B-plus through a single earphone unit. The phone is bypassed with a .002-μf capacitor mounted in its case. The probe is made from a phone plug. The metal tip is cut off close to the end of the barrel and replaced with a long brass screw that has been filed to a sharp point. This screw is insulated from the metal end of the barrel. A .0001-μf ceramic condenser and a 4- or 5-megohm resistor are mounted inside the barrel of the probe. The shield of the r.f. cable is a ground connection between the tester and the set.

Multitester

The multitester section is constructed around a 0.5-ma d.c. meter with a multimeter scale. Ranges, selected with S5, are 0-50-250-1,000 volts d.c., 0-50-1,000 volts a.c., 0-5-50-250 ma d.c., and 0-150,000 ohms.

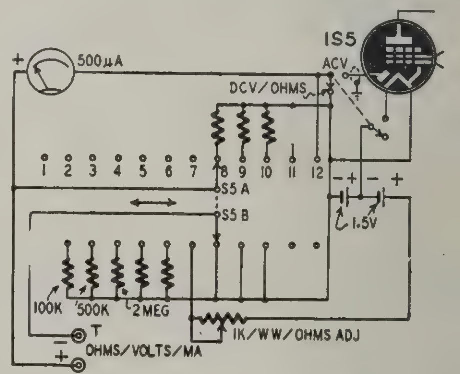
Alternating voltages are measured by using the meter in conjunction with the diode of the 1S5 when S1 is on A.C. VOL. One section supplies 1.5 volts for the filament from one of the penlite cells and the other connects the diode to the meter through shunts and multipliers.

The unmarked shunts and multipliers are selected according to the meter used. Series multipliers are metallized resistors and shunts are hand-wound to the proper values on small bakelite strips.

When measuring resistances, the meter is connected as a series-type ohmmeter consisting of the meter, a 1,000-ohm rheostat (zero-ohms adjuster) and the 2 penlite cells in series. Resistances up to 150,000 ohms can be measured.

To test condensers, set S5 on position 11, plug prods into jacks marked T-C and close push-button switch S4.

Continuity tests are made with S5 on position 12, S1 on D.C.V./OHMS and prods plugged into the multimeter jacks. This places a 3-volt flashlight bulb in series with the prods and the penlite cells. This section is useful in repairing shorted variable condensers.

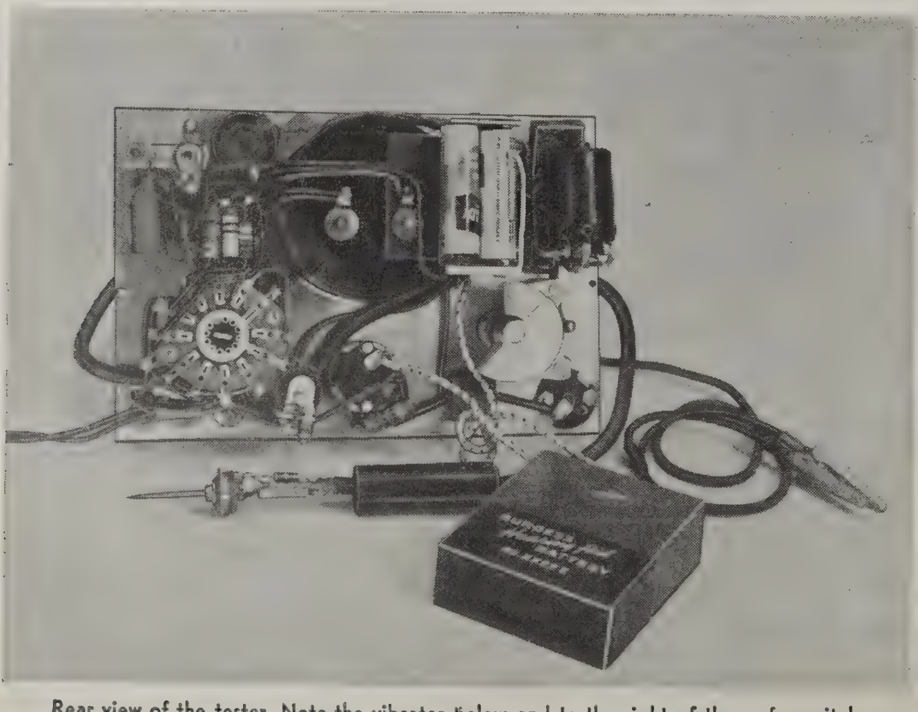


A break-down diagram of the multitester unit.

When the tester is set for condenser tests, it can be used as a polarity indicator by connecting prods to the external d.c. voltage and noting which electrode of the neon lamp glows when the positive prod is connected to a known positive voltage. Both plates glow on a.c. When testing for polarity of an external voltage do not press S4.

Wiring the range switch, S5, is perhaps the most difficult operation in the construction of the tester. This is simplified by wiring each deck separately. Functions for the various positions are:

Position	*Function*
1.	OFF
2.	50 v.d.c.
3.	250 v.d.c.
4.	1000 v.d.c.
5.	50 v.a.c.
6.	1000 v.a.c.
7.	OHMS
8.	5 ma d.c.
9.	50 ma d.c.
10.	250 ma d.c.
11.	Condenser Test (TC)
12.	Continuity (L)



Rear view of the tester. Note the vibrator below and to the right of the wafer switch.

MONEY BACK GUARANTEE— We believe units offered for sale by mail order should be sold only on a "Money-Back-If-Not-Satisfied" basis. We carefully check the design, calibration and value of all items advertised by us and unhesitatingly offer all merchandise subject to a return for credit or refund. You, the customer, are the sole judge as to value of the item or items you have purchased.

THE NEW MODEL 670

SUPER METER

SUPER METER. A Combination VOLT - OHM - MILLIAMMETER plus CAPACITY REACTANCE, INDUCTANCE and DECIBEL MEASUREMENTS.

D.C. VOLTS: 0 to 7.5/15/75/150/750/1500/7500. **A.C. VOLTS:** 0 to 15/30/150/300/1500/3000 Volts. **OUTPUT VOLTS:** 0 to 15/30/150/300/1500/3000. **D.C. CURRENT:** 0 to 1.5/15/150 ma.; 0 to 1.5 Amps. **RESISTANCE:** 0 to 500/100,000 ohms, 0 to 10 Megohms. **CAPACITY:** .001 to .2 Mfd., .1 to 4 Mfd. (Quality test for electrolytics.) **REACTANCE:** 700 to 27,000 Ohms; 13,000 Ohms to 3 Megohms.

INDUCTANCE: 1.75 to 70 Henries; 35 to 8,000 Henries.

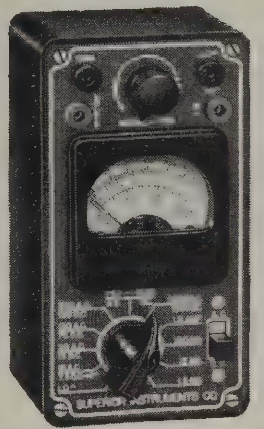
DECIBELS: —10 to +18, +10 to +38, +30 to +58.

The model 670 comes housed in a rugged, crackle-finished steel cabinet complete with test leads and operating instructions. Size 5½" x 7½" x 3".

$28.40 NET

The New Model 770 — An Accurate Pocket-Size

VOLT-OHM MILLIAMMETER



(Sensitivity: 1000 ohms per volt)

Features:

Compact-measures 3⅛" x 5⅞" x 2¼". Uses latest design 2% accurate 1 Mil. D'Arsonval type meter. Same zero adjustment holds for both resistance ranges. It is not necessary to readjust when switching from one resistance range to another. This is an important time-saving feature never before included in a V.O.M. in this price range. Housed in round-cornered, molded case. Beautiful black etched panel. Depressed letters filled with permanent white, insures long-life even with constant use.

Specifications: 6 A.C. VOLTAGE RANGES: 0-15/30/150/300/1500/3000 volts.
6 D.C. VOLTAGE RANGES: 0-7½/15/75/150/750/1500 volts.
4 D.C. CURRENT RANGES: 0-1½/15/150 Ma. 0-1½ Amps.
2 RESISTANCE RANGES: 0-500 ohms. 0-1 Megohm.

The Model 770 comes complete with self-contained batteries, test leads and all operating instructions.

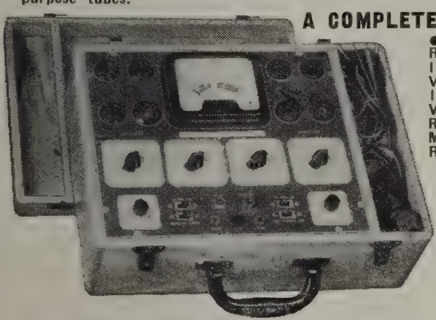
$13.90 NET

The New Model 606

TUBE & SET TESTER

A COMPLETE TUBE TESTER

● Tests all tubes including the new post-war miniature loctals such as the 12AT6, 12AU6, 35W4, 50B5, 11723, etc. ● Tests by the well-established emission method for tube quality, directly read on the scale of the meter. ● Tests shorts and leakages up to 3 Megohms in all tubes. ● Tests leakages and shorts of any one element against all elements in all tubes. ● Tests both plates in rectifiers. ● Tests individual sections such as diodes, triodes, pentodes, etc., in multi-purpose tubes.



A COMPLETE MULTI-METER

● 6 D. C. VOLTAGE RANGES: 0 to 7.5/15/75/150/750/1,500 Volts ● 6 A.C. VOLTAGE RANGES: 0 to 15/30/150/300/1,500/3,000 Volts ● 4 D.C. CURRENT RANGES: 0 to 1.5/15/150 Ma. 0 to 1.5 Amps. ● LOW RESISTANCE RANGE: 0 to 2,000 Ohms (1st division is 1/10th of an ohm.) ● 2 MEDIUM RESISTANCE RANGES: 0 to 20,000/200,000 Ohms ● HIGH RESISTANCE RANGE: 0 to 20 Megohms ● 3 DECIBEL RANGES: —10 to +38 +10 to +38 +30 to +58 D.B.

Model 606 comes housed in a beautiful hand rubbed oak cabinet complete with portable cover, test leads, tube charts, and detailed operating instructions

$47.85 NET

THE NEW MODEL 777

20,000 OHMS PER VOLT!!

TUBE & SET TESTER

Tube Tester Specifications:
★ Tests all tubes including New Miniatures, etc. Also Pilot Lights. ★ Tests by the well-established emission method for tube quality, directly read on the scale of the meter. ★ New type line voltage.

V.O.M. Specifications:

* **D.C. VOLTS:** (at 20,000 Ohms Per Volt), 0 to 7.5/15/75/150/750/1,500 Volts.

* **A.C. VOLTS:** (At 10,000 Ohms Per Volt), 0 to 15/30/150/300/1,500/3,000 Volts.

* **D.C. CURRENT:** 0 to 1.5/15/150 Ma. 0 to 1.5 Amperes.
* **RESISTANCE:** 0 to 5,000/50,000/500,000 Ohms. 0 to 50 Megohms.

Model 777 operates on 90-120 volts 60 cycles A.C. Housed in beautiful hand-rubbed cabinet. Complete with test leads, tubes, charts and detailed operating instructions. Size 13" x 12½" x 6".

$59.95 NET

The Model S-35 — a POWERFUL

REFLEX PROJECTOR

COMPLETE WITH BUILT-IN DRIVER UNIT CONSERVATIVELY RATED AT 35 WATTS—HANDLES UP TO 55 WATTS WITHOUT BLASTING. DRIVER UNIT MFG. BY WESTERN ELECTRIC.

Heavy gauge aluminum in the main trumpet section completely eliminates blasting and blaring. New plastic diaphragm overcomes the resonant peaks of the old type; also it is absolutely impervious to atmospheric changes whereas the old type was subject to atmospheric corrosion. Complete unit unconditionally guaranteed for one year.

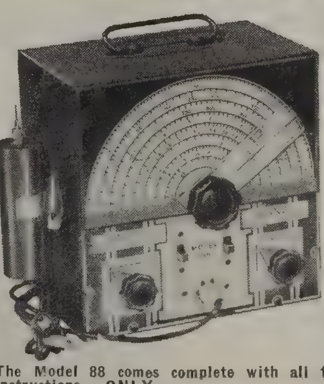
Specifications

POWER (CONSERVATIVE) — 35 WATTS; AIR COLUMN—3½ FT.; DISPERSION—80°; POWER (PEAK) —55 WATTS; BELL DIAMETER—15"; IMPEDANCE—8 ohms; FREQUENCY RANGE—130 to 5000 C.P.S. PROJECTION — ½ mile; FINISH — Attractive two tone crystalline. The Model S-35 Comes Complete with Built-in Driver Unit, ONLY

$28.50 NET

The Model 88 — A COMBINATION

SIGNAL GENERATOR AND SIGNAL TRACER



Signal Generator Specifications:

*Frequency Range: 150 Kilocycles to 50 Megacycles. *The R.F. Signal Frequency is kept completely constant at all output levels. *Modulation is accomplished by Grid-blocking action which is equally effective for alignment of amplitude and frequency modulation as well as for television receivers. *R.F. obtainable separately or modulated by the Audio Frequency.

Signal Tracer Specifications:

*Uses the new Sylvania 1N34 Germanium crystal Diode which combined with a resistance-capacity network provides a frequency range of 300 cycles to 50 Megacycles.

The Model 88 comes complete with all test leads and operating instructions. ONLY

$28.85 NET

20% DEPOSIT REQUIRED ON ALL C.O.D. ORDERS

GENERAL ELECTRONIC DISTRIBUTING CO.

DEPT. RC-9 98 PARK PLACE, NEW YORK 7, N. Y.

Bridge Measures L-C-R

Building an accurate instrument for measuring radio parts values

By RUFUS P. TURNER

FOR good all-around flexibility and dependability, the skeleton-type impedance bridge is unequalled for reliable resistance, capacitance, and inductance measurements. It is distinguished from other L-C-R bridges in that it employs plug-in standards that reduce the errors caused by stray capacitances in the range-switch circuits ordinarily employed in home-made L-C-R bridges.

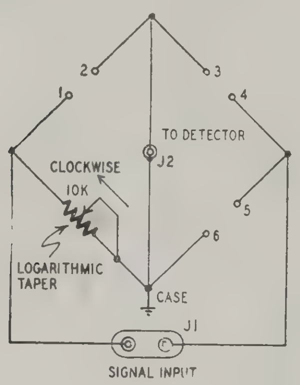


Fig. 1—Schematic shows simplicity of bridge.

The bridge has plug-in terminals in three of its four arms. By simply shifting the standards and the unknown component among these terminals, the bridge may be converted from the Wheatstone type (for resistance measurements) to the Wien type (capacitance) or to the Maxwell type (inductance).

Any convenient signal source, such as an audio oscillator or the low-voltage output of a 60-cycle filament transformer, will supply a.c. input to the bridge. Any convenient null detector may be employed. Satisfactory null detectors include headphones, audio amplifiers with electron-ray indicator tubes, oscilloscopes, and a.c. vacuum-tube voltmeters. In some instances non-electronic a.c. voltmeters have been used with some success. When making resistance measurements, the a.c. signal source and detector may be dispensed with and a battery connected to the bridge input terminals; a center-zero d.c. microammeter or bridge galvanometer may be connected to the bridge output.

The skeleton-type bridge is easy to build and calibrate. The circuit is shown in Fig. 1. The only adjustable element is the rheostat, which carries a direct-reading dial. The terminals, 1-2, 3-4, and 5-6, are provided for plug-in standards and the resistor, capacitor, or coil under test. Signal voltage is injected into the bridge through jack J1, and the null detector is plugged into jack J2.

While any 10,000-ohm wire-wound rheostat or potentiometer might be used, a rheostat having a logarithmic taper affords an open, easily readable dial. Ordinarily, logarithmic rheostats are rather costly, but an excellent component of this type recently has appeared in the surplus market at a very low price.

The skeleton bridge described in this article is patterned after the discontinued General Radio type 625-A and is a simplification of a similar bridge previously developed by the author.* It has the following ranges: resistance, .01 ohm to 1 megohm in 7 steps; capacitance, 1 μμf to 100 μf in 7 steps; inductance, 1 μh to 100 h in 7 steps.

The bridge ranges may be changed by plugging in standard resistors and capacitors of appropriate value (see Tables 1, 2, and 3). The dial of the rheostat (Fig. 2) can be read directly in ohms, micromicrofarads, microfarads, microhenries, millihenries, or henries.

The following standards are required for complete coverage of the resistance, capacitance, and inductance ranges:

1 1-ohm resistor
1 10-ohm resistor
2 100-ohm resistors
2 1000-ohm resistors
2 10,000-ohm resistors
1 0.0001-μf capacitor
1 0.001-μf capacitor
1 0.01-μf capacitor
1 1.0-μf capacitor

*See *Radio Test Instruments* by Rufus P. Turner

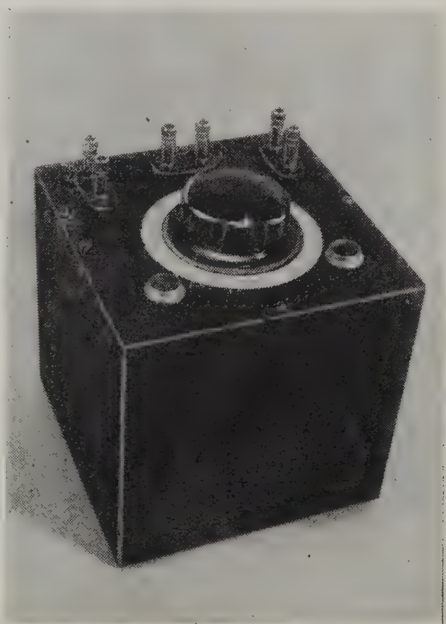


Fig. 2—Bridge is built in square steel box.

The accuracy of the bridge depends upon the accuracy of these standards. Precision, non-inductive wire-wound resistors should be employed (they are not expensive) and the capacitors should have at least a 1% accuracy rating.

Construction

The author's bridge (See Figure 2) is built in a standard 6 x 6 x 6-inch steel box. The terminal posts take wire leads and banana jacks.

Signal input jack J1 is a female 2-terminal connector. Bridge output jack J2 is a female co-axial connector. Different types of jacks are used because the input and output terminals of the bridge cannot both be at ground potential without short-circuiting the rheostat, which would be the case if co-axial jacks were used in both positions.

The dial is 3½ inches in diameter and has a metal skirt. A disc of thick white drawing paper is cemented to the metal disc and the graduations from zero to 10 (see Fig. 2) are draw on this paper.

The standard resistors and capacitors should be mounted inside small boxes or cans provided with banana plugs that fit into the terminal posts of the bridge.

Wiring must be done with stiff bus wire run by the shortest route between circuit points. Fig. 3 gives a clear view of the simple wiring. Be sure to connect the rheostat so that resistance increases with counter-clockwise rotation.

Calibrating the bridge

The skeleton bridge is calibrated by marking the rheostat dial in resistance units. Connect to terminals 1 and 2 a well-calibrated ohmmeter or a resistance bridge of good quality. Temporarily connect wire jumpers between terminals 3 and 4 and between terminals 5 and 6.

Rotate the knob until the ohmmeter or external bridge reads 100 ohms. Mark this point on the scale. Repeat at as many points as possible between zero and 10,000 ohms. Remove the jumpers from the bridge terminals. Remove the dial from the rheostat shaft and ink in the lines permanently. Mark the 1,000-

ohm point 1, the 2,000-ohm point 2, and so on up to 10. Then carefully replace the dial.

The accuracy of the calibration will depend upon the precision of the external meter or bridge used, the care with which the dial points are inscribed, as well as the care with which the dial is replaced on the rheostat shaft after inking.

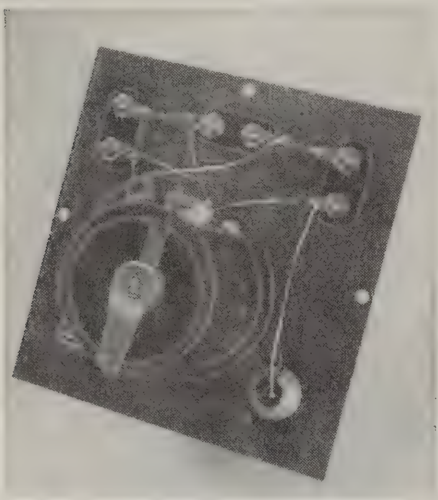


Fig. 3—Wiring is rigid and leads are short.

Operating the bridge

An a.c. signal is used for most measurements. This is supplied in most cases by an audio oscillator. Connect the oscillator and the null detector to the bridge with short lengths of flexible shielded cable. Fig. 4 shows the bridge supplied by an audio oscillator and connected to an oscilloscope used as the null detector. This is a very sensitive arrangement.

Plug in the standards and connect the unknown resistor, capacitor, or inductor as indicated in Tables 1, 2, and 3. Adjust the rheostat for a sharp null. Read the resistance, capacitance, or inductance of the unknown from the dial, according to the range given in the table. If no null is obtained with a given set of standards, change the standards to the next range.

Very often, a sharp null is not obtained during capacitance checks. This is due to capacitor power factor. For sharpening the null and for measuring the power factor, the scheme shown in Fig. 5 is recommended. A calibrated

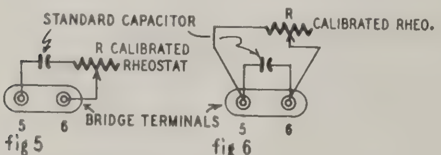


Fig. 5—Extra rheostat measures power factor.
Fig. 6—Adjust R for the sharpest indication.

rheostat, R, is connected in series with the standard capacitor and bridge terminals 5 and 6. The rheostat must be connected by the shortest possible leads. R is adjusted along with the bridge dial until the sharpest null is obtained. At this point, the power factor of the capacitor under measurement may be deter-

TABLE 1
Resistance measurement

Range (ohms)	Terms. 1-2 (ohms)	Terms. 3-4 (ohms)
.1-1	10,000	1
0.1-10	10,000	10
1-100	10,000	100
10-1,000	10,000	1,000
100-10,000	10,000	10,000
1,000-100,000	1,000	10,000
10,000-1,000,000	100	10,000

Connect unknown resistor to terminals 5-6.

mined by means of the formula, Power Factor (%) = $.000628\ fRC_x$ where f is the bridge signal frequency in cycles, R is the resistance of the auxiliary rheostat at its null, and C_x is the value of the unknown capacitor in microfarads.

A sharp null often cannot be obtained in inductance measurements because of the resistance of the coil under test. To improve this situation, a calibrated rheostat, R, is connected in parallel with the standard capacitor and bridge terminals 5 and 6, Fig. 6. R then is adjusted along

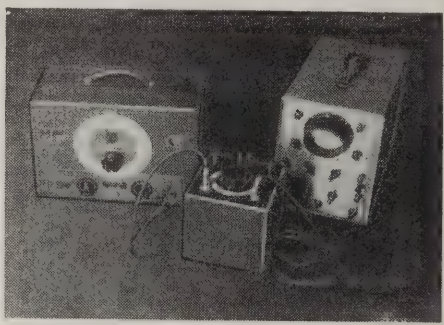


Fig. 4—Bridge used with generator and 'scope.

with the bridge dial to give the sharpest null. At this point, the equivalent series resistance of the coil may be determined by the formula, Equivalent Series Resistance (ohms) $= \frac{R_s R_p}{R}$ where R_s is the standard resistor connected to terminals

TABLE 2
Capacitance measurement

Range	Terms. 1-2 (ohms)	Terms. 5-6 (μf)
1-100 μμf	10,000	.0001
10-1,000 μμf	10,000	.001
100 μμf-.01 μf	10,000	.01
.001-0.1 μf	1,000	.01
.01-1 μf	10,000	1
0.1-10 μf	1,000	1
1-100 μf	100	1

Connect unknown capacitor to terminals 3 and 4.

3 and 4, R_p is the resistance of the main bridge rheostat at its null, and R is the resistance of the auxiliary rheostat at its null. Use the shortest possible leads between the rheostat and the bridge terminals.

To check resistance by the d.c.-bridge method, connect a 1½- to 4½-volt battery to jack J1, and a zero-center d.c. microammeter (100-0-100, 50-0-50 or lower) to jack J2. Connect a pushbutton switch in series with the battery and J1. Set up the bridge for resistance according to Table 1. As the bridge dial is rotated, depress the pushbutton intermittently, noting whether null is approached. As the meter deflection approaches null, the pushbutton may be held down safely. Exact null, of course, is indicated by zero meter deflection.

TABLE 3
(Inductance measurement)

Range	Terms. 3-4 (ohms)	Terms. 5-6 (μf)
1-100 μh	1	.01
10-1,000 μh	10	.01
100 μh-10 mh	100	.01
1-100 mh	1,000	.01
10-1,000 mh	10,000	.01
0.1-10 h	1,000	1
1-100 h	10,000	1

Connect unknown coil to terminals 1 and 2.

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Four-Band Converter Has Crystal Control

By HERBERT S. BRIER, W9EGQ

THE big problems in designing high-frequency receiving equipment are instability, drift (have you ever tried to use the crystal filter of your receiver on 6 or 10 meters?), and a high signal-to-noise ratio. The first two cease to be problems with crystal-controlled equipment.

The pictures and diagram show the simplicity of this crystal-controlled converter. With it, any well-shielded receiver, capable of covering a frequency range equal to the width of the desired band, becomes a sensitive receiver for that band. All receiver controls are used in the normal manner. Even the dial calibration can be used if a judicious choice of crystals is made. With the converter oscillator producing a 20-mc output, for instance, a 28.5-mc signal will beat with it to give an 8.5-mc input to the receiver; a 29-mc signal will give a 9-mc input to the receiver; and so on. The same relationship can be had in other bands. The crystal table lists a few of the crystal frequencies which may be used.

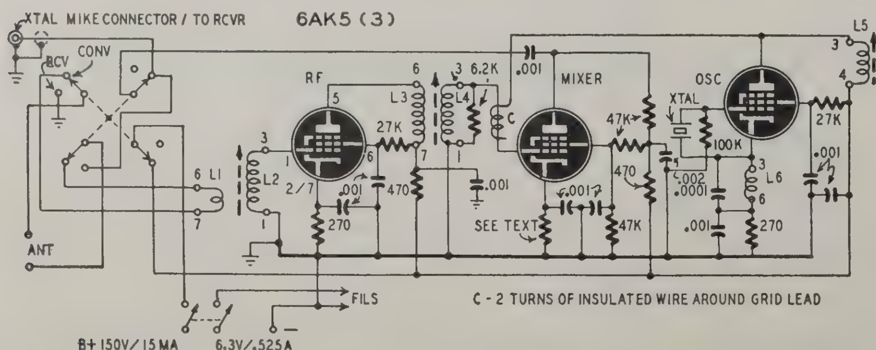
The extreme stability of the converter is especially noticeable when receiving weak DX signals through interference.

Below is a schematic diagram of the converter. Assuming that 10- and 11-meter signals are to be received, the slug-tuned r.f. and mixer coils L2 and L4 are resonated to 28.5 mc. Being heavily loaded, L4 allows approximately equal amplification of all signals between 27 and 30 mc. The 27- to 30-mc signals beat with the 20-mc oscillator to produce 7- to 10-mc difference frequencies at the plate of the mixer tube. The difference frequencies are fed into the receiver, the tuning of which determines which signal will be further amplified and detected.

Tight antenna coupling broadens the response of L2 sufficiently to cover the desired frequency range, and it puts the greatest possible signal on the grid of the r.f. amplifier—necessary for the best signal-to-noise ratio. L4 is loaded by a 6,200-ohm resistor and by being closely coupled to L3.

The receiver to be used with the converter must be practically dead without an antenna; otherwise unwanted signals at the converter output frequency will leak through and interfere with the desired signals. Make the test at night when the signals are loudest. Disconnect the antenna, temporarily shielding the terminals, if necessary. One or two weak signals can be tolerated, because the noise contributed by the converter will cover them up; but strong signals will cause annoying interference.

With a "souped-up" BC-348 there was enough pickup from the antenna terminal for some commercial c. w. signals to push the S meter well up the scale. Use of crystal microphone connecters and a shielded lead between the converter and the receiver eliminated the unwanted signals when the converter's antenna switch was not used. However, with the switch and with an antenna having considerable pickup at the undesired frequencies, weak signals would feed through the small capacitances between the switch contacts.



The schematic diagram shows how simple the converter is. Three miniature tubes are used.

This does not occur with antennas using half-wave elements fed with low-impedance feeders (300 ohms or less), and the switch does provide a convenient method of switching the converter in and out of the circuit; but with long-wire antennas or high-impedance feed lines, some spurious signals may leak through.

All coils, except the oscillator cathode coil, are wound on Millen type 74001, slug-tuned, shielded, plug-in forms.

In construction, the parts layout closely follows the electrical sequence. The box used was 4⅜ x 7 x 3⅜ inches, but a larger box with a hinged top is recommended.

CRYSTAL TABLE

Crystal Freq. (Mc)	Crystal Harmonic	Signal Frequency (Mc)	Receiver Dial
4	4th	21-21.5	5-5.5
5	3rd	21-21.5	6-6.5
	4th	27-30	7-10
6.667	2nd	21-21.5	7.666-8.156
	3rd	27-30	7-10
10	Fund.	21-21.5	11-11.5
	2nd	27-30	7-10
14.667	Fund.	21-21.5	6.333-6.833
	3rd	50-54	6-10
20	Fund.	27-30	7-10
	2nd	50-54	10-14

To obtain short leads the coil and tube sockets in the r.f. and mixer stages are turned so that pin 3 (the grid connection of each coil socket) is adjacent to pin 1 (control grid) of the tube sockets, and in the oscillator so that pin 3 (the plate connection) of the coil socket is adjacent to tube socket pin 5 (plate). Pin 3 is the hot one on all coils, and the numbers on the diagram indicate the pins used for the remaining connections.

Winding data for all coils is given in the coil table.

All components below the chassis are hung in place wherever convenient, aided by tie lugs. All grounds are made directly to the chassis, and the only shielding required, in addition to that

(Continued on page 56)

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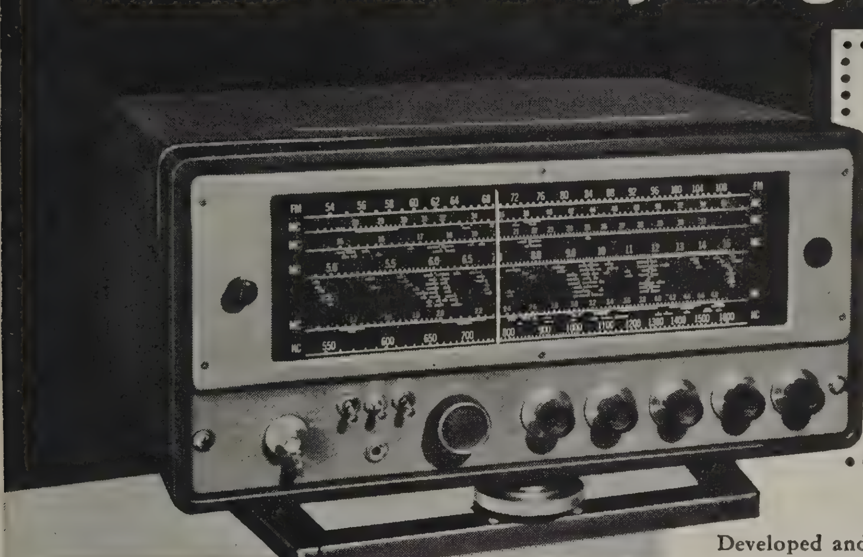

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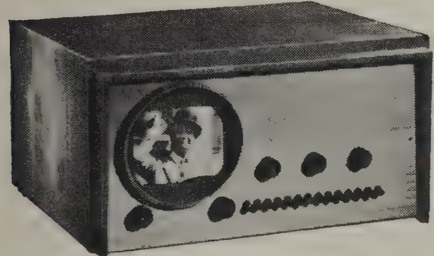

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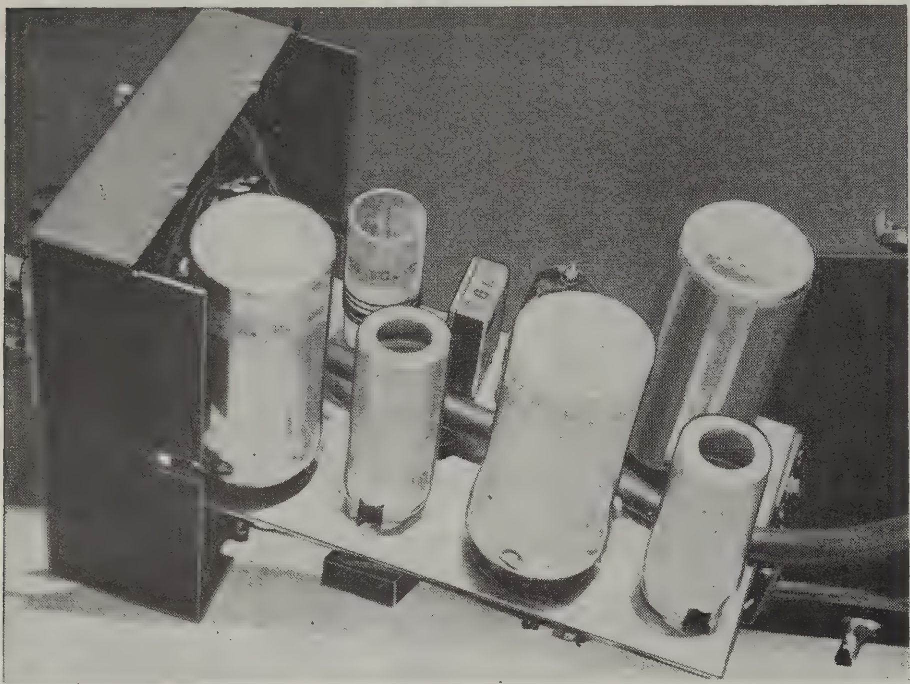


R.f. and mixer tubes are covered with shields. Wind all coils except L6 on shielded forms.

supplied by the coil and tube shields, is the shielded output lead.

Preliminary adjustment

To put the converter in operation, insert the 28-mc coils, tubes, and crystal; connect the converter output to the receiver antenna terminal through a shielded line; and apply the proper voltages. Connect a low-range voltmeter across the oscillator cathode resistor and adjust the slug in L4 for minimum reading on the meter. The crystal oscillator signal should be clearly received when the receiver is tuned to the crystal frequency or a harmonic thereof; removing the crystal will cause the signal to disappear and will increase the meter reading slightly.

If a signal generator is available, set it to 28.5 mc and couple it loosely to the converter input. Tune the receiver dial around 8.5 mc until the signal generator is heard, and adjust the slugs in L2 and L4 for maximum output. If a signal generator is not available, simply set the receiver dial to 8.5 megacycles and adjust the slugs for maximum noise output with no antenna connected to the converter. When the antenna is connected, there will be a great increase in background noise; and if the band is open, signals can be tuned in by moving the receiver dial between 7.16 and 9.7 mc. The antenna will detune the input circuit somewhat, and the slug in L2 should be readjusted with the receiver dial set at 8.5 mc. Its setting will be much less critical than before.

The same procedure is followed with the 50-54-mc coils; however, if it is necessary to triple or quadruple the fundamental crystal frequency to reach 40 mc in the oscillator, it is quite difficult to tune the oscillator plate circuit to resonance by observing the variation in voltage across the cathode resistor because the voltage is so small. A receiver tuned to 40 mc can be used, by tuning the slug for maximum signal strength; but the easiest method is to leave the 28-mc coils in the r.f. and mixer stages and, with the receiver dial set to 11.5 mc, to adjust the slug in the 40-mc oscillator coil for maximum signal. Output of the mixer will still be at the difference frequency between r.f. and oscillator signals, but the oscillator will be operating above the r.f. The converter will work as well on 27 to 30 mc as before, but the receiver dial calibration will be backwards.

Once the oscillator is peaked, insert the remaining 50-54-mc coils and adjust as outlined for the 28-mc band. The receiver dial should be set near 12 mc and the signal generator to 52 mc. 50 to 54 mc will correspond to 10 to 14 mc on the receiver. Coils for the 21-mc band are similarly adjusted.

L1, as specified, is approximately correct for 300-ohm feeders. For feeders of different impedance, the number of turns must be changed for best results. Three turns should be correct for 75 ohms, and 10 turns for 600 ohms, on 28 megacycles. On 50 megacycles two to six turns are recommended. The more turns used, the more L2 is loaded. Up to a point the signal-to-noise ratio also improves. The antenna itself has some bearing on how heavily the input circuit may be loaded. An antenna having considerable pickup at the converter output frequency will cross modulate the 6AK5 grid when coupled too tightly, and signals will ride through without regard to the position of the slugs in the coils. When this effect is present, the antenna is overcoupled; and reducing the number of turns in L1 not only eliminates the trouble, but also increases the strength of the desired signals.

An improvement in signal-to-tube-hiss ratio may be obtained by adjusting the mixer bias. Temporarily replace the mixer cathode resistor with a 10,000-ohm potentiometer. Replace the antenna with a resistance of the same value as the feeder impedance to eliminate outside signals. Pick up a weak, locally generated signal, and adjust the mixer bias to the value that gives the greatest signal-to-noise ratio. Before adjustment, the S meter may read S6 with signal and drop to S4 without signal. Increasing the bias may drop the meter reading to S5 with signal, and at the same time drop the no-signal reading to S1, obviously a tremendous improvement in signal-to-noise ratio. After the optimum value is found, the actual resistance in the circuit is read with an ohmmeter, and the process repeated for another band. The optimum value will be different on each band, because it depends on the amount of oscillator voltage being injected into the mixer grid. Use the lowest resistance, because — within limits—higher resistance merely reduces mixer sensitivity slightly without affecting the over-all signal-to-noise ratio. However, if the resistance is less than 1,000 ohms on any band, it indicates that insufficient oscillator voltage is being injected into the mixer grid. Wrap another turn of the wire forming capacitor C around the mixer grid lead and repeat the procedure.

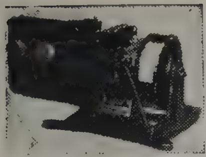
When the converter is used with a BC-348 receiver, bands 4 and 5 cover only 6-9.5 and 9.5-13.5 mc, according to the dial calibration. Nevertheless, without turning the band switch, the entire 6- and 10-11-meter bands can be covered by turning the dial beyond the calibrated portion of the scale for the high-frequency ends of these bands.

COIL TABLE
Turns

	Signal Frequency (Mc) 21-21.5	27-30	50-54	REMARKS
L1	10	7	4	Over grounded end of L2.
L2, L3, L4	22	15	6	Closewound. L3 near top of form; L4 separated from L3 by 1-16 inch.
L5	43	22	11	Closewound

	Crystal Frequency (Mc) 4	5	6.667	10	14.667	20	
L6	20	18	15	10	7	4½	5-10-mc, closewound. 10-mc, spaced wire diameter. 14-20-mc, spaced to ½-inch.

All coils wound with No. 24 enamelled wire, except L5 for 21-21.5 mc and L1 for all bands, which are wound with No. 28. L1 to L5 are made on Millen 74001 x ½-inch-diameter shielded slug-tuned forms, L6 on ¾-inch plain forms.



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DM 21	14	3.3	235	.090	BC 312	3.45LN
DM 21CX	28	1.6	235	.090	BC 312	3.45N
DM 25	12	2.3	250	.050	BC 367	2.49LN
DM 26R	28	1.25	275	.070	BC 348	5.75
DM 33	28	7	540	.250	BC 456	5.50N
DM 42	14	46	515 1030 2/8	.110 .050	SCR 506	6.50LN
PE 55	12	25	500	.400	SCR 245	5.25LN
PE 86 N	28	1.25	250	.060	BC 36	3.95N
PE 101 C	13/26	12.6/ 6.3 9	400 800 AC	.135 .020 1.12	SCR 515	5.25N
BD AR 93	28	3.25	375	.150		4.95N
23350	27	1.75	285	.075	APN-1	3.50N
35X045B	28	1.2	250	.060		3.50N
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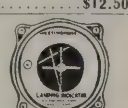

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2J26	15.00	714AY	15.00
2J27	15.00	715-B	12.00
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2J32	15.00	721-A	3.60
2J38	25.00	723-A/B	7.75
2J39	25.00	724B	1.75
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2J22	3267—3333 mc.	265 K.W.	15.00
2J26	2992—3019 mc.	275 K.W.	15.00
2J27	2965—2992 mc.	275 K.W.	15.00
2J32	2780—2820 mc.	285 K.W.	15.00
2J38 Pkg.	3249—3263 mc.	5 K.W.	25.00
2J39 Pkg.	3267—3333 mc.	8.7 K.W.	25.00
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For 2J21 725-A, 2J22, 2J26, 2J27, 2J31, 2J32, and 3J31 ....Each $8.00

4850 Gauss, ⅝" bet. pole faces, ¾" pole diam...... 8.00

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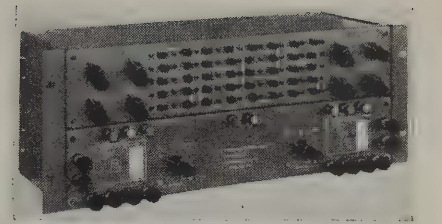

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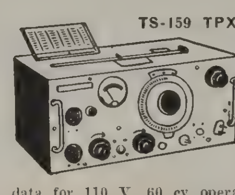

TS-159 TPX Measures frequency between 150 & 200 mc. by heterodyne method. Power of Xmtr can be directly measured. Measures DC voltages up to 500 Volts. Original operation on 110 V. 400 cy. but conversion kit makes it operable on 110 V. 60 cy. new, complete with tubes, crystal, cal. chart, antenna, meter & conversion kit and data for 110 V. 60 cy operation $29.95

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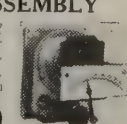

Rotates any coupled shaft by means of motor thru 90 deg. at rate of 5 deg. per min. Operates on 55-110 vac, 60 cy. Manual knob permits rough adjustment. W.W. #B 401020G. New, complete with cover and 0-90 deg. indicator scale **$12.50**

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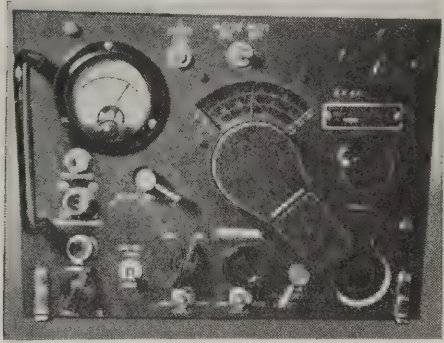
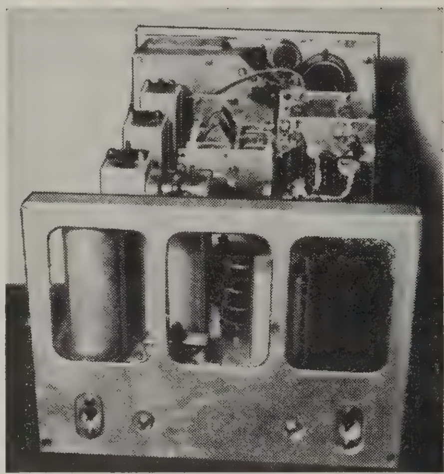
Modifying the R-44/ARR-5



Front view of the set after conversion.

This set makes a top-notch FM receiver



Rear of the R-44/ARR-5 v.h.f. receiver.

By L. W. MAY, JR., W5AJG

THE type R-44/ARR-5 v.h.f. receiver is one of the better pieces of military radio equipment to appear on the surplus market. It is the military version of the Hallicrafters' S-36A v.h.f. FM-AM-C.W. receiver used in the services as an airborne search receiver for locating enemy radar and communication channels between 27 and 143 mc. The old and new FM broadcast bands and the 11-, 10-, and 6-meter amateur bands are included in this range; therefore this set will prove equally useful as an FM broadcast receiver or a v.h.f. receiver for the amateur bands.

This set can be used as is by adding a suitable power supply and loudspeaker; however, some changes and modifications improve its over-all performance and adaptability for civilian use.

The R-44/ARR-5 was used with the AN/APA-10 panoramic adapter or AN/APA-6 radar indicator to provide visual indications. These units were connected to the receiver through co-axial connectors on the front panel. A motor-driven scanning device was provided for continually tuning back and forth over any predetermined section of the tuning range.

After carefully checking the circuits of the ARR-5 and the commercial counterpart, the S-36A, we found that the major circuit differences are in the audio circuit. The S-36A has a push-pull output stage capable of several watts undistorted audio output, while the ARR-5 has a single output stage delivering only 50 milliwatts of audio. A video output connection for feeding the AN/APA-6 radar indicator was made in the cathode circuit of the 6V6 a.f. amplifier. The r.f. and i.f. channels are practically identical and with a few changes in both the a.f. and r.f. sections, the ARR-5's performance can be made to approach that of the S-36A.

R.f. circuit alterations

The modifications are not at all difficult and can be made by anyone familiar with v.h.f. receiver construction. To start with, the ARR-5 has an extra r.f. amplifier stage using a 956 tube in a reradiation suppressor stage. This is an untuned r.f. stage (Fig. 1) in a separate shielded box between the antenna terminals and the standard r.f. section.

(*Continued on page 60*)

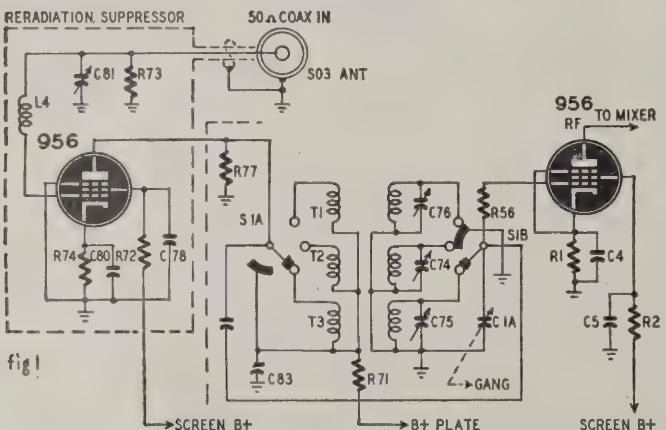


fig 1

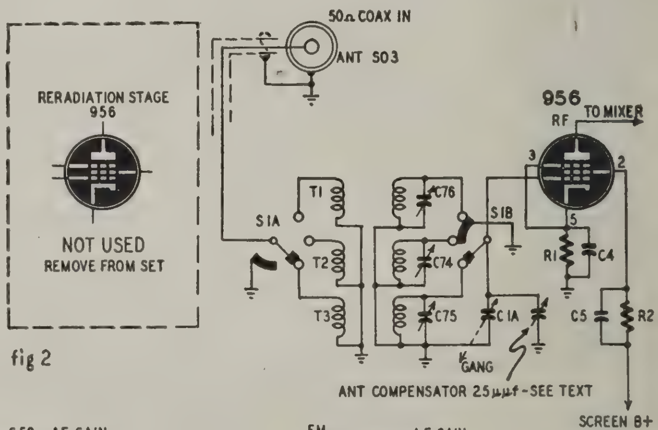


fig 2

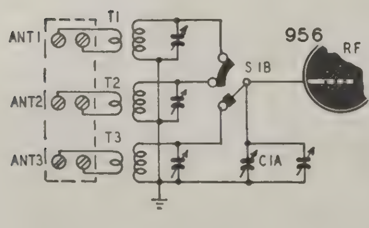


fig 3

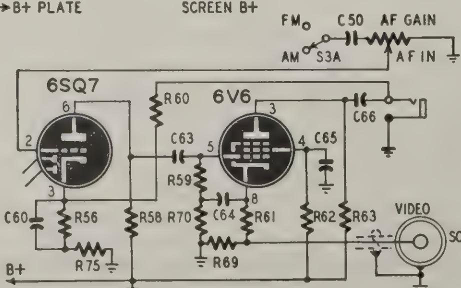


fig 4

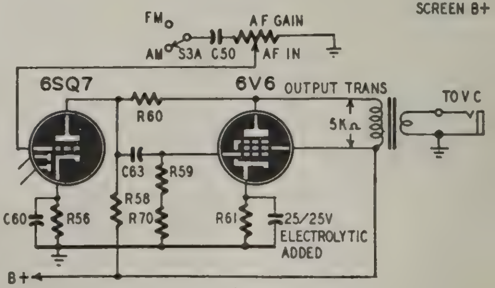


fig 5

Fig. 1—R.f. circuit of the R-44/ARR-5 before conversion. Fig. 2—The r.f. circuit of the receiver after conversion. The reradiation stage is removed bodily from the chassis. Fig. 3—An optional connection permitting separate attenas for each tuning range. Fig. 4—Note the circuit of the combination audio-video output stage before conversion. Fig. 5—The output stage after conversion is completed.

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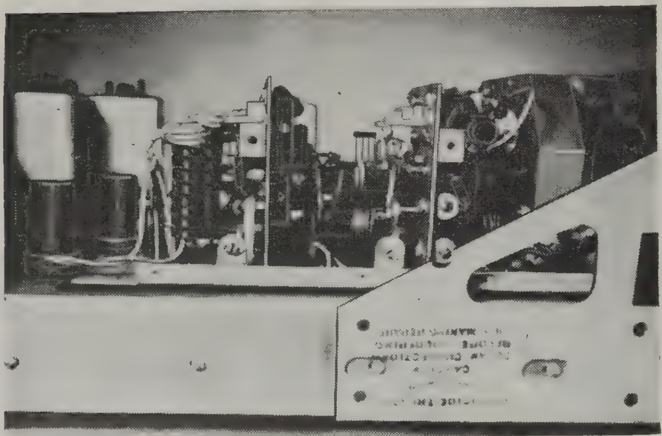


The reradiation stage was originally located on the rear of the sub-chassis supporting the r.f. and oscillator assemblies. The original antenna coils were replaced with coils wound from thin copper strips. This change resulted in an overall gain increase of 6 to 10 db. The antenna primaries were wound with rather heavy bus bar covered with suitable insulating material.

of the receiver. Its purpose is to suppress any radiation from the receiver itself, thereby preventing the enemy from employing direction-finding techniques to spot its location. Its efficiency in suppressing any signal leaking out of the receiver is remarkable. Unfortunately, it also does a fair job of suppressing any incoming signal as well, making the ARR-5 receiver relatively insensitive and leaving much to be desired in the way of a good v.h.f. job. This situation is easily corrected by eliminating the reradiation suppressor stage and rerouting the antenna input directly into the first 956 r.f. amplifier stage (Fig. 2).

Balanced 400-ohm antenna feeder systems are employed exclusively on the v.h.f.'s at W5AJG/W5JKM. Since the ARR-5 is set up for a co-axial input of 50 ohms impedance, changes were made in the mechanical construction of the set to accommodate balanced inputs.

Referring to Figs. 1 and 2, the before-and-after circuits of the r.f. section, and to the photographs taken after modification, it is seen that the suppressor stage has been removed bodily and an opening provided in the side of the first r.f. stage compartment for the new balanced leads to emerge. The primaries of transformers T1, T2, and T3 were used for the plate-coupling windings of the suppressor tube, so they have a relatively high impedance. We use 400-ohm lines, so these windings are removed entirely and lower-impedance links of a few turns substituted to serve as the antenna pickup coils. It is possible, by reducing the number of turns to fit the particular antenna in use, even to use the windings without removing them. After doing this, the coupling is still rather loose. This may result in insufficient antenna pickup and transfer. At this particular installation, the coupling proved to be insufficient with the original cut-down primaries. Hence the new windings and closer coupling.

Coupling capacitor C83 is also removed, and the antenna is connected in on the arm of S1A. If a 50-ohm co-axial input is employed, the original front panel receptacle labelled ANT can be used and one side of the antenna coils returned to ground. If separate antennas are used, say one for 10 meters, one for 6 meters and one for the new 88-108 mc FM broadcast band, three separate inputs could be provided on the terminal plate on the side of the r.f. compartment and switch section S1A neglected altogether. This connection is shown in Fig. 3.

With these changes in the r.f. section, and after routine alignment of the trimmers C74, C75, and C76, performance is better than with the reradiation suppressor stage in the circuit. Signals should average about 20 to 30 db stronger. This is quite an improvement, and some users may find the increase in gain sufficient for their needs. However, this arrangement did not satisfy us for long and additional changes were made.

In tracking the front end it was noted that the receiver's wide frequency range makes it practically impossible to get one antenna to look entirely resistive over the whole range. An antenna compensator was added across C1A to peak the received signal. This is a small 25-μμf variable condenser conveniently mounted on the underside of the chassis, in the present location of the a.f. gain control. Remove this control and push it aside, leaving the wiring intact. Install the antenna compensator and drill a 3/8-inch hole through the chassis. This will come out directly under the first section of the main tuning condenser. Use a piece of strap copper about 1/32 inch thick and 1/4 inch wide to connect the two stators together, and another piece to ground securely the bracket which carries the antenna compensator. The a.f. gain control may be mounted on a small piece of bracket material soldered to the chassis or screwed to anything convenient and controlled from the front panel by an extension shaft. The co-axial antenna input receptacle was removed, and the audio volume control shaft extends out through this opening.

The panoramic adapter outlet was left connected as it is convenient for working out of the r.f. section into a regular communications receiver set at 5.25 mc. This affords greater selectivity than the ARR-5 is capable of providing because FM i.f. transformers are used. Be sure to use a blocking condenser, as the mixer plate voltage appears on the outlet.

A.f. circuit alterations

The 6V6 video output stage has an audio output of only 50 milliwatts (see Fig. 4). The circuit was altered as in Fig. 5. The output transformer should be of fair quality for best FM reception, and may be mounted in place of the filter choke L3 which isn't needed since sufficient filter may be included in the power supply. All necessary changes are shown on the before-and-after audio-section schematic and all are of minor importance. Only one component is added, a cathode bypass condenser for the output tube.

No power supply is included. Any normally well filtered supply providing 250 to 275 volts d.c. at about 100 ma and 6.3 v a.c. at approximately 2 amperes may be used. The scanning motor requires 24 volts d.c. at less than 1/2 ampere, if this feature is utilized. The power input receptacle is replaced by a 5-prong socket.

Optional modifications

After the set had been working for a few days, we decided that there was a chance that we were losing some signal in the r.f. coils, which were wound on bakelite forms. Consequently, T1, T2, and T3 were all removed, the recently wound antenna primaries being included and carefully laid aside so that they could be reinstalled should the coming experiment prove disastrous.

First, a length of common copper strip about 1/32-inch thick and 1/4-inch wide was connected from the ground point of the rotor on the main tuning to the ground side of the r.f. grid coils. Another piece of this material was used for winding the coils themselves, in a spiral fashion, making a very rigid air-supporting structure. The new low-impedance antenna coils were then wound from rather heavy bus wire. On the first try, nothing would resonate—it seems that when using this flat copper ribbon or strip material for coils, approximately *twice as many turns* are required as when using ordinary wire coils.

After increasing the number of turns on the copper-ribbon coils, the r.f. stage performed beautifully. By tuning in a known station and watching the S-meter, it appeared that a worth-while improvement resulted.

With these changes the ARR-5 becomes a very desirable piece of v.h.f. receiving gear, versatile and very usable. It is suspected that lots of v.h.f. men grabbed this set for the same purpose for which the writer uses it primarily — that is, checking the muf *(maximum usable frequency)* between 30 and 50 mc. Intelligently used in this manner, it will save many fruitless hours of listening to dead 50-mc air. One v.h.f. enthusiast contacted, who used an ARR-5 for this purpose, avowed he would set up the sector automatic tuning and insert a relay in the a.v.c. system, so when a signal was scanned by the automatic mechanism, the set would stop on the signal and ring a warning bell, indicating that 50 mc was in business. Could be—anyway, it's food for thought.

Relay-Controlled Ham Rig

The c.w. key controls the whole station

By RICHARD H. DORF, W2QMI

THE control system of this 60-watt c.w. transmitter was designed after the writer saw a number of ham stations where changing over from receive to transmit involved throwing three or four switches, unplugging a pair of phones and going through a moderate acrobatic routine.

Pressing the key puts the station on the air, switches the antenna to the transmitter, and silences the receiver. When keying is finished the receiver automatically comes on again, the antenna swings over to it, and the transmitter goes off. A self-contained audio keying monitor operates a small loudspeaker on the transmitter panel. This control system was designed for this rig but can be readily applied to any size c.w. transmitter.

The rig is a standard oscillator-amplifier combination. As the schematic, Fig. 1 shows, a 6V6 Pierce oscillator drives an 807 power amplifier. Depending on the power-supply voltage, outputs up to 50 watts are possible.

Five crystal sockets and a selector switch are provided for quick frequency change. 80- and 40-meter crystals can be used for the 80- and 40-meter bands or 80-meter crystals can be used for 40 meters by using the final stage as a doubler. This, however, impairs efficiency and reduces the power output.

The oscillator cathode is keyed so that the transmitter can be used for break-in work, if desired. The OD3/VR150 voltage regulator keeps the oscillator plate and screen voltages almost constant, so there is no perceptible chirp. The click filter (RFC1, RFC2, C1, C2, and R1) is so effective that no clicks can be heard even when the receiver is placed right next to the transmitter.

The oscillator is capacitively coupled to the 807. Try different values for C3 if the 807 grid current is less than 3.5 ma with the key down.

Grid-leak bias is used on the 807 to avoid the loss of plate voltage that would be caused by a cathode resistor. A 6V6 is connected between screen and ground to prevent the 807 from burning up when there is no signal (key up) and no bias. When the key is up there is no bias on the 6V6 and it draws maximum plate current. This large current, passing through the 807 screen resistor, R2, causes a large voltage drop across it. The voltage on the screen is, therefore, very small. This prevents 807 plate current from rising to more than about 40 ma.

When the oscillator is keyed the grid-leak bias on the 807 is applied through the 100K isolating resistor to the grid of the 6V6. This cuts off the 6V6 and restores the 807 screen voltage to its normal value.

A Collins pi-network is used in the output. Two coils, one for each band, are switched in and out. Any single-wire antenna can be used. The pi will load anything from a lead pencil to a steel tower. The commercial coils used have end links, so a balanced feeder can be used in place of the single wire. Usually, a separate antenna-tuning network will be required for that.

The power supply shown uses a combination-type power transformer, though separate plate and filament transformers can be substituted. The condenser-input filter gives poor regulation but a high output voltage, 600 volts in this case. Since the OD3/VR150 takes care of the oscillator, the poor regulation in the final does not matter.

The control system

Three single-pole keying relays are used because a 3-pole keying relay seems to be hard to find. Any fast-acting low-voltage relays are usable; the ones here are 5,000-ohm, 4-ma sensitive units. They operate nicely on about 20 volts.

The first relay, RY1, keys the oscillator cathode. RY2 keys the voice coil of the audio monitor oscillator speaker. RY3 operates the control circuits which take care of antenna changeover and receiver disabling.

The control circuit uses one half of the 6N7. R4 and C6 are a series RC time-constant circuit. When the key is up and the contacts of RY3 are open, 22.5 volts from the battery are applied to the grid through R4 and C6. There is no drop across R4 because there is no current flowing through it—C6 acts as a blocking capacitor. With 22.5 volts on the grid, no plate current flows and RY4 is open.

When the key is pressed the contacts of RY3 close and short the grid to ground. This reduces the bias to zero, plate current flows and RY4 closes. This energizes RY5, which switches the antenna over to the transmitter and opens the receiver disabling circuit.

When the key is opened after making each dot and dash the short across C6 is removed. However, the capacitor takes time to charge up and the full 22.5 volts do not appear between grid and ground until it does charge. If the key is pressed again, for the next character, before the grid voltage has time to reach a value that would cause RY4 to open, RY4 stays shut and the station stays on the air. If, however, keying is finished, and the key is not pressed again the grid

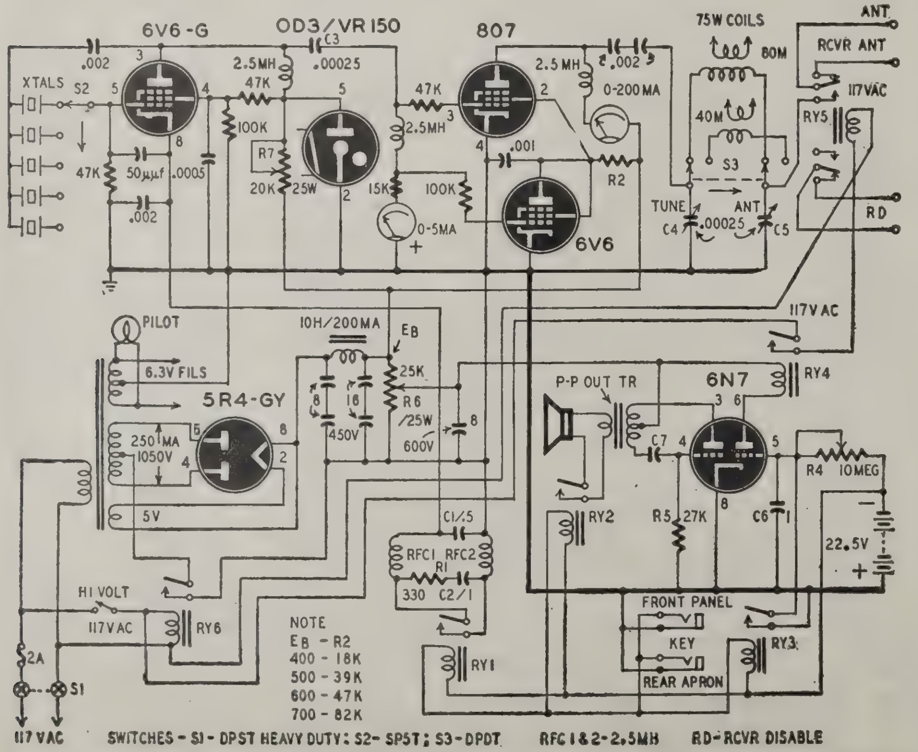


Fig. 1—Six relays are used in the transmitter. The antenna may be a random length of wire.

voltage will reach cutoff and RY4 will open, turning on the receiver and switching the antenna.

The time taken for C6 to charge depends on the values of C6 and of R4 and the battery voltage. The time in which the capacitor will charge to about 67 percent of the battery voltage is equal to C in microfarads times R in megohms. With the 10-megohm resistor and 1-μf capacitor, the maximum time is about 10 seconds. However, the 10-megohm resistor is variable, so the operator can set time according to his own average keying speed. If he is a speed demon, the time can be short; if he is an average or slow-speed operator the time and the resistor setting will have to be larger so RY4 will not open between characters.

The other half of the 6N7 is an audio oscillator. The transformer may be any push-pull output unit. The grid leak, R5, and C7 may be changed to give a different tone. If necessary, a small capacitor can be shunted across the transformer primary. A 3-inch speaker was used since compactness, not fidelity, was the important point. The audio oscillator is keyed by RY2 and gives a good indication of the operator's keying, though transmitter output signal should be checked occasionally for roughness.

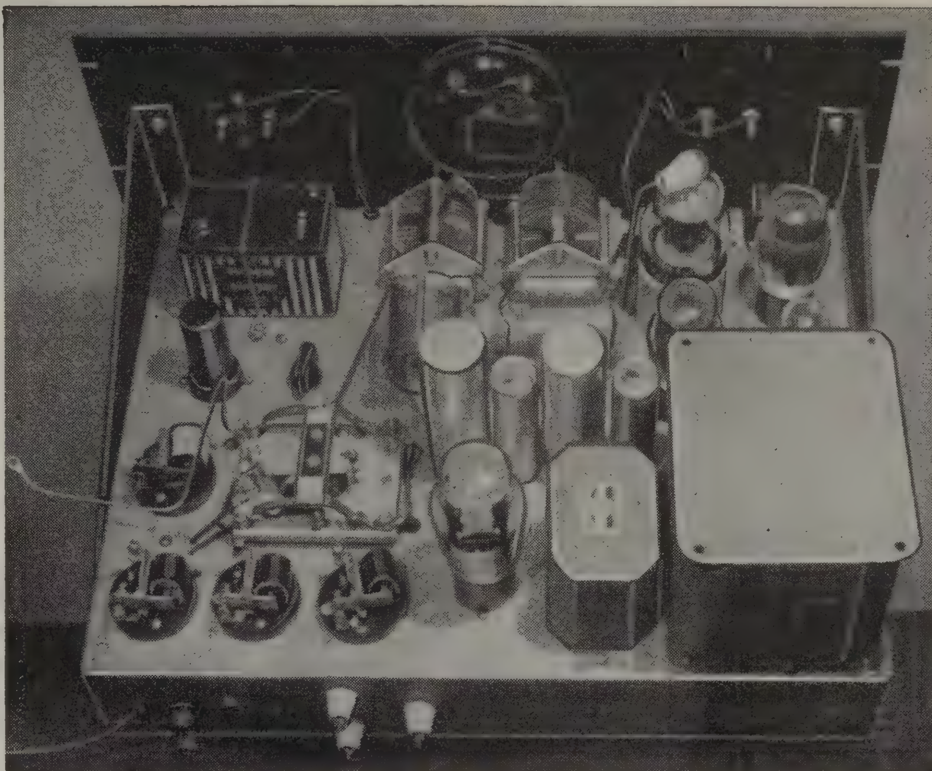


Fig. 2—The power supply is shown at the lower right in the picture. Coils are at center.

Construction

A 13 x 17 x 3-inch chassis was big enough for all the components, but not too big, so don't try to economize on a chassis. Fig. 2 shows how the parts are mounted. The oscillator tube is at the upper right in the photo with the 807 next to it. The 6V6 screen-control tube and the OD3/VR150 are below these two. A standard 807 shield is included to minimize spurious oscillation. The battery is fastened to the chassis with a yoke of stiff bus bar. The small black pointer knob controls the resistance of R4.

The two coils are mounted at right angles to each other so the field of one will not cut the turns of the other.

Underneath the chassis (Fig. 3) the coil switch is fastened down with an angle bracket and an extension shaft is used to avoid long leads. The audio transformer is on the right. At bottom is RY6, which is controlled by a panel switch and breaks the center tap of the high-voltage transformer winding for long standby periods.

Fig. 4 shows the front panel with the transmitter mounted in a metal cabinet. Height of the panel is 8¾ inches and width is 19 inches. In addition to the key jack on the front panel there is one on the rear apron so that a key can be plugged into either place.

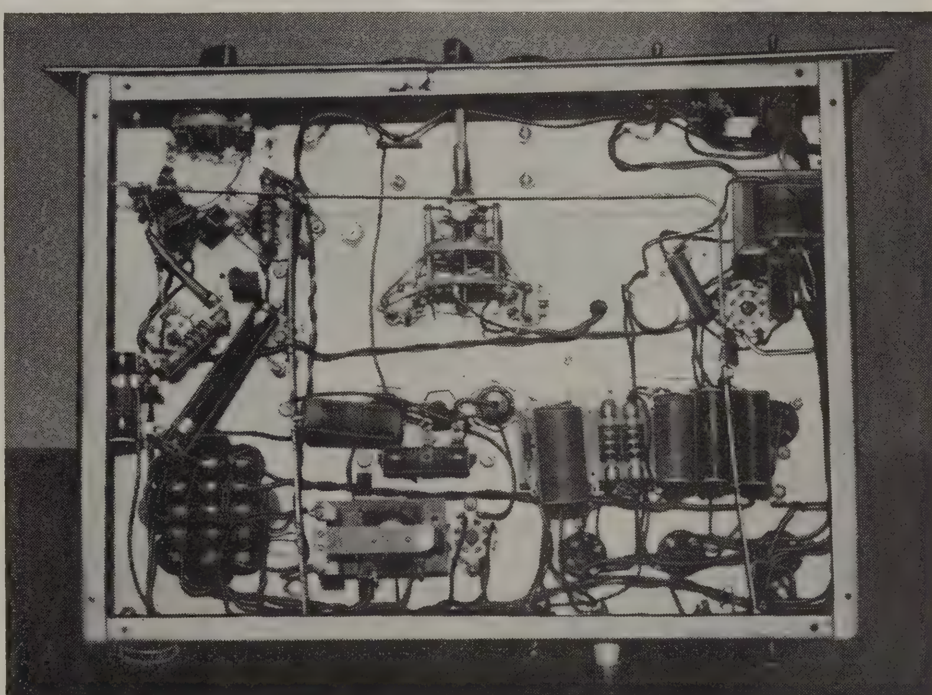


Fig. 3—The high-voltage relay is under the chassis. There is little crowding of parts.

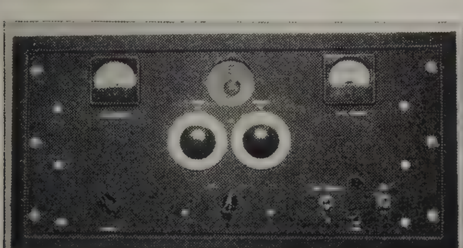


Fig. 4—The front-panel layout is symmetrical.

Transmitter adjustment

Place the tap on the bleeder (R6) at the ground end, remove the 6N7, and adjust R7 for maximum resistance.

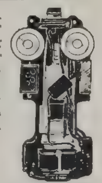
Now turn on the HIGH-VOLTAGE switch. See that the 807 plate current does not go above about 40 ma.

Insert a milliammeter between the cathode (pin 2) of the OD3/VR150 and ground and adjust the tap on R7 for 25-ma. Replace the cathode connection.

Connect an antenna to the transmitter and clamp RY5 shut with a paper clip. Turn on the high voltage, press the key, and, with C5 at maximum capacity, tune C4 for a plate-current dip. Now, rotating C5 will load the antenna. Advance it in small steps, retuning C4 each time for a dip, until 807 current is 100 ma.

Replace the 6N7 and advance the tap on R6 until RY4 closes when the key is pressed. Remove the paper clip from RY5. Now pressing the key should put the transmitter on the air and operate all the control circuits: Adjust R4 until the time delay is satisfactory.

If the monitoring tone in the loudspeaker is too loud, a series resistor can be inserted in series with the transformer secondary and the voice coil.



People

HARRY DIAMOND DIES

Harry Diamond, Chief of the Electronics Division of the National Bureau of Standards, died suddenly June 21.

One of the inventors of the radio proximity fuze (No. 2 secret weapon of World War II). Mr. Diamond was widely honored for his work. Among the acknowledgments he had received were the 1940 Award for Engineering Achievement of the Washington Academy of Sciences; the Naval Ordnance Development Award for Exceptional Service, 1945, and the War Department Certificate for Outstanding Service.

Mr. Diamond played a large part in the development of the Instrument Landing System (ILS) and participated in the first completely blind flight and landing of an aircraft, which took place in March 1933.

Another development of world importance in which he had a major role is the radiosonde. His other contributions to the radio art include visual beacons for air-craft guidance, antenna systems, range-beacon course-alignment procedures, a simultaneous phone and beacon-range system, aircraft-engine ignition shielding, automatic weather stations, upper-air wind velocity determination by radio, a method for measuring direction-finder polarization errors, and director for electronic bombs.

PHILCO'S NEW VICE-PRESIDENT

Radcliffe L. Romeyn has been appointed Vice-President and Factory Export Manager of the International Division of Philco Corporation. For the past two years Mr. Romeyn has served as Factory Export Manager. He will continue the same duties with added responsibilities in his new position as Vice-President.

RCA APPOINTS NEW OFFICIALS

Glen McDaniel has been elected a vice president of the Radio Corporation of America to serve on the president's staff.

David C. Adams, assistant general counsel of the National Broadcasting Company, has been elected vice-president and general attorney of RCA Communications, Inc.

FARNSWORTH ENGINEER DIES

Charles J. Lemieux, senior engineer in charge of the Capehart laboratory of Farnsworth Television & Radio Corporation died June 26 at the age of 44. Mr. Lemieux was with the Farnsworth Corporation eight years and was in charge of the Materials Testing Division seven years.

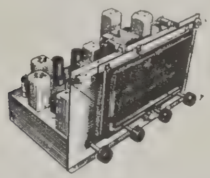
Prior to joining Farnsworth he was with the International Detrola Corporation. He was widely known in the radio components industry and was a member of the RMA Safety Committee.

FM-AM TUNER

Browning Laboratories, Inc.
Winchester, Mass.

The RJ-12A tuner has separate AM and FM circuits. Both sections include an r.f. amplifier.

Sensitivity of the FM section is less than 10 μv for 30-db noise reduction. Two limiters are used in the Armstrong circuit. FM audio response is flat from 10 to 15,000 cycles. A compensation network eliminates frequency drift after a 2-minute warmup period.



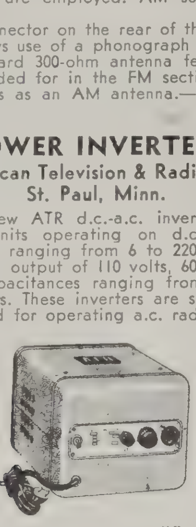
Audio response of the AM section is flat from 20 to 6,600 cycles $\pm$3 db. Recently developed triple-tuned i.f. transformers are employed. AM sensitivity is 5 μv.

A connector on the rear of the chassis allows use of a phonograph pickup. A standard 300-ohm antenna feed line is provided for in the FM section; the line acts as an AM antenna.—RADIO-CRAFT

POWER INVERTERS

American Television & Radio Co.
St. Paul, Minn.

The new ATR d.c.-a.c. inverters include units operating on d.c. input voltages ranging from 6 to 220, delivering an output of 110 volts, 60 cycles, with capacitances ranging from 75 to 500 watts. These inverters are specially designed for operating a.c. radios, PA

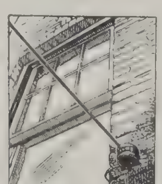


systems, television sets, amplifiers, small a.c. motors, and electrical appliances from d.c. sources. Featured is an automatic switching unit for use with 32- and 110-volt d.c. inverters, permitting automatic starting and stopping of these units as the load is turned on and off. More than 33 different standard inverter types are offered.—RADIO-CRAFT

WINDOW-MOUNT ANTENNAS

Vertrod Corp.
New York, N. Y.

New window-mounting FM and TV antennas are offered for those who cannot or may not install standard antennas on their roofs. The units mount outside the window and project outward to a maximum of 45 inches.



The cylindrical ceramic base houses an electrical network which permits the use of 300-ohm balanced line for the lead-in. Three models are offered. They appear to be similar, but they differ in the network contained in the ceramic housing. They are for TV and FM, FM and AM, and TV, AM, and FM.—RADIO-CRAFT

V.T.V.M.

Triplett Electrical Instrument Co.
Bluffton, Ohio

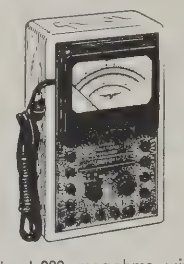
Model 2451 electronic volt-ohm-milliammeter measures up to 1,000 volts a.c. or d.c. and 50 volts r.f., 1 ampere d.c., and 100 megohms resistance. An important feature is that the meter may be zeroed on the range to be used, rather than having to be switched to the basic range for adjustment.

A detachable crystal-diode r.f. probe may be plugged into the instrument for measuring frequencies as high as 100 mc. An additional probe can be purchased to extend the range to 400 mc. Input resistance on the d.c. ranges is 11 megohms.—RADIO-CRAFT

MULTIMETER

Radio City Products Co.
New York, N. Y.

Model 450 series Hi-Meg meters include a resistance range for measur-



ing up to 1,000 megohms without an external battery. Other ohms ranges extend to 5 megohms.

The meters are available with sensitivities of 1,000, 5,000 and 20,000 ohms per volt. All models have ranges up to 2,500 volts d.c. and 1,000 volts a.c., 1 ampere, and —9 to +55 db.—RADIO-CRAFT

POCKET-SIZE TESTER

Precision Apparatus Co.,
Elmhurst, N. Y.

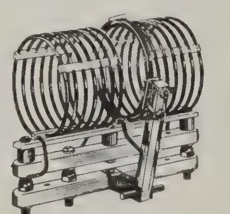
The Series 40 circuit tester is contained in a Bakelite case 3¾x6¼x2½ inches. It includes 31 a.c. and d.c. ranges to 6,000 volts, 600 ma, 70 db and 5 megohms.

The meter is a 3-inch, 400-μa instrument. Two pin jacks are used for all ranges, except the 6,000-volt one, for which a recessed safety jack is provided. A rotary switch selects the desired functions.—RADIO-CRAFT

HAM INDUCTORS

E. F. Johnson Co.
Waseca, Minn.

Air-wound inductors for the final stages of amateur transmitters are of-



fered in several types. Two models for each band provide for matching high-current, low-voltage or low-current, high-voltage tubes. Various links to match transmission-line impedances may be plugged into the swinging link arm.

The inductors are supported on polystyrene. Each part of the assembly is available separately.—RADIO-CRAFT

WIDE RANGE METER

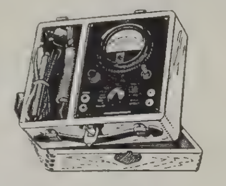
Triplett Electrical Instrument Co.
Bluffton, Ohio

Model 625-NA is a wide-range volt-ohm-milliammeter with a 6-inch mirror-scale meter for better reading accuracy. Ten d.c. voltage ranges extend up to 5,000 at 10,000 and 20,000 ohms per volt. A.c. voltages up to 5,000 volts at 10,000 ohms per volt are in five ranges. There are three resistance ranges up to 40 megohms, and six direct-current ranges from 50 μa to 10 amps. A decibel scale on the meter is calibrated from -30 to 69 db. The instrument is housed in a black molded-bakelite case with a removable strap handle.—RADIO-CRAFT

MULTIMETER

Bradshaw Instruments Co.,
Brooklyn, N. Y.

Model 10-F covers 25 ranges, including capacitance to 10 μf, a.c. to 15 amperes, a.c. and d.c. volts to 1,000,



direct currents to 1 ampere, and resistance to 2 megohms.

The tester, which is offered in both bench and portable models, contains a fuse to protect the meter movement. A 3-inch meter is used.—RADIO-CRAFT

V.H.F. GENERATOR

Rollin Co.
Pasadena, Calif.

The Model 30 power-type standard signal generator tunes from 40 to 400 mc. Maximum output is 5 watts (15 volts). An attenuation network brings output down to a minimum of 0.1 μv.

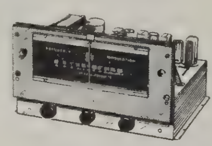
The spiral dial scale has an effective length of nearly 4 feet, and calibration marks are inserted at 1% frequency intervals. Leakage fields are less than 0.1 μv per meter.—RADIO-CRAFT

FM TUNER

Collins Audio Products Co.
Westfield, N. J.

This tuner covers the 88-108-mc FM band. It is permeability-tuned and, according to the maker, has no frequency drift.

The Armstrong circuits used include two cascade limiters. Included in the 11 tubes is a 6AL7-GT tuning indicator. Sensitivity is 10μv, assuring good reception at some distance from the transmitter.—RADIO-CRAFT



TUBE TESTER

General Electric Co.,
Syracuse, N. Y.

The Type YTW-1 facilitates rapid checking of receiving tubes. A large degree of flexibility is attained through the use of individual circuit switches for each tube element.

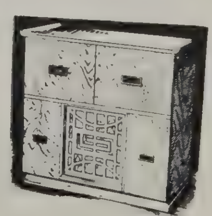
Tubes accommodated include 4-, 5-, 6-, 7-, and 8-pin standard types, 5-pin small, 7- and 9-pin miniatures, and lock-in types. Batteries and pilot lights can also be tested.

The YTW-1 is an emission-type tester. It also checks for filament continuity (without waiting for warmup) and open and shorted elements. Weight of the unit is 15 pounds.—RADIO-CRAFT

RADIO CABINETS

Nemes
Chicago, Ill.

One of the great problems in putting together radiophonographs from component parts is finding a cabinet.



These cabinets are constructed to order. Size, style, and type of wood may be specified by the purchaser.—RADIO-CRAFT

SOLDERING IRON

Jett Thermal Device Co.
Brooklyn, N. Y.

The Slim Jim soldering iron weighs only 3½ ounces. By what the manufacturer calls the "wattage expanding principle," the thermal cartridge concentrates all its heat in the tip instead of wasting a large amount in useless radiation. This allows a 30-watt car-

tridge to furnish as much useful heat as the normal 100-watt iron.

With the transformer, which also acts as a holder, the iron works on 117 volts a.c. Without the transformer, a 6-volt car battery furnishes suitable power.

Tips, made of a nonoxidizing material, are replaceable. Cartridges of different wattages may be inserted.—RADIO-CRAFT

RADIO SILENCER

Kenworth Mfg. Co.
Milwaukee, Wis.

Radi-Off automatically turns off the radio when the telephone receiver is lifted off the cradle, and turns it on again when the receiver is replaced. No electrical connection need be made to the telephone.

A shallow metal box is placed under the telephone instrument. The top of the box is spring-mounted so that, as the telephone's weight decreases (when the receiver is removed), the box top rises slightly and opens an internal switch contact, turning off the radio.

Connection to the radio is made by plugging the radio's line cord into a receptacle wired to the Radi-Off and plugging the latter into the wall socket.

The device is adjustable for the weights of different telephones.—RADIO-CRAFT

SMALL CAPACITORS

Solar Mfg. Corp.
North Bergen, N. J.

Type TST Tiny, Sealdtites are tubular moulded paper capacitors. 3/16 inches in diameter x ⅝ inch long.

They are molded in Hi-Temp plastic compound for satisfactory operation under the high operating temperatures found in miniaturized electronic equipment and personal radios. Unlike conventional thermosetting molding materials, the Hi-Temp plastic compound housing withstands extremes of humidity.—RADIO-CRAFT

MOBILE TRANSMITTER

Standard Transformer Corp.
Chicago, Ill.

The ST-203-A amateur transmitter is designed for operation in an automobile, but can be used also at a fixed station. Operating in the 10-meter band, its maximum plate power input is 27.5 watts. Power requirements are 400-500 volts d.c. at 200 ma. and 6 volts a.c. or d.c. at 2.8 amperes.

Five tubes are used. They are: 6V6 r.f. oscillator, 2E26 power amplifier, 6J5 speech amplifier, and two push-pull 6V6 modulators. The transmitter may be controlled from the driver's seat by the push-to-talk button on the microphone.

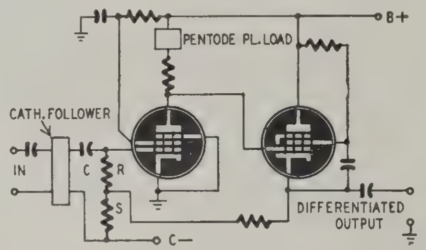
The unit is provided with a base mounting plate for installation in an automobile trunk. The transmitter fastens to the base plate with two spring-loaded catch fasteners. Dimensions are 8⅝ x 7⅜ x 6¾ inches.—RADIO-CRAFT

DIFFERENTIATION CIRCUIT

Patent No. 2,436,891
Wm. A. Higinbotham, Santa Fe, N. M.
(assigned to United States of America as represented by the Secretary of War)

Differentiating circuits are important in television and electronic counters (see page 26, July RADIO-CRAFT). To differentiate a voltage, it is connected across a series condenser and resistor. The output appears across the resistor. For an accurate differentiated output R must be negligible compared with C. Unfortunately, this results in practically no output.

This new circuit combines accurate differentiation with high output. It is shown below. The input passes through a cathode follower for isolation from the differentiating circuit C, R, S. The voltage drop across the two resistors is amplified and then transmitted to the beam power cathode follower. The cathode current of this tube flows through S.



The voltage drop across S is made up of two parts. One is due to the original differentiated current. The other is produced by a reverse current similar to the first but greatly amplified. These voltages can be made to almost cancel. Therefore the combined effect of R and S is negligible as required.

The accurately differentiated voltage appears at the cathode load of the beam power tube.

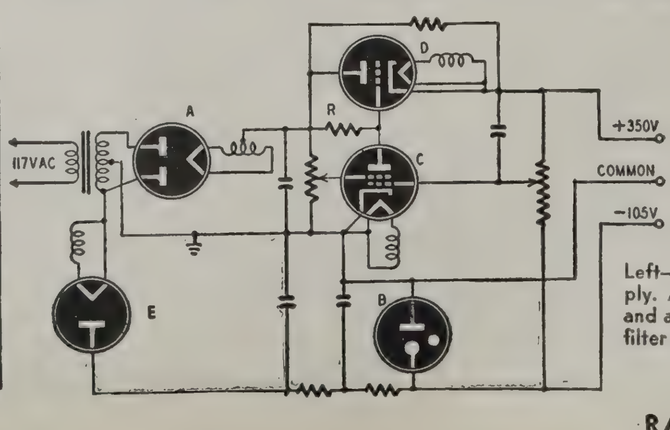
VOLTAGE REGULATOR

Patent No. 2,434,069
Harold Goldberg, Irondequoit, N. Y.
(assigned to Stromberg-Carlson Co.)

Regulated power supplies which provide high voltages at fairly heavy loads use at least the following tubes: rectifier, voltage regulator, pentode, and triode. In the figure these are illustrated, respectively, as A, B, C, and D. To describe briefly the operation, assume that the output voltage (across the bleeder) undergoes an increase for any reason. The control grid of the pentode then assumes a more positive potential and causes greater plate current to flow through R. There is an increased voltage drop across this resistor and therefore the triode grid becomes more negative. The higher tube resistance is in series with the power supply, consequently the output drops and compensates for the original rise. When properly adjusted, such a circuit can maintain an output voltage constant to within a small percentage.

In the circuit illustrated, the voltage regulator tube B is used simultaneously to regulate a second voltage, for example, for bias purposes. To do this it is necessary only to add a half-wave rectifier tube E and a filter system. The filter may be a simple R-C combination because of the low drain of the C supply. The regulator tube not only standardizes the grid potential of the pentode tube but also the negative voltage output.

This circuit is especially useful in connection with class C amplifier power supplies.



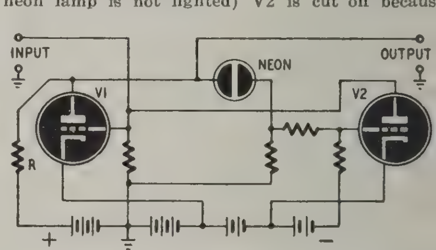
Left—A regulated power sup ply. Addition of an extra tube and a simple resistance-capacit filter provides a source of bias

TRIGGER CIRCUIT

Patent No. 2,441,006
Arthur E. Canfora, Brooklyn, N. Y.
(assigned to Radio Corp. of America)

This circuit is controlled by a neon lamp. Th two triodes are connected so that when one con ducts the other is cut off. Change-over takes plac when a pulse of correct polarity operates th first tube.

If the input is positive V1 conducts. Its plat voltage drops to a low value due to heavy curren through R and the neon lamp cannot light. Th grid resistor of V2 is connected through the lam and R to the positive terminal of the powe supply. If this path is interrupted (when th neon lamp is not lighted) V2 is cut off becaus



its grid is also connected to the negative en of the supply. If the input pulse is negative V is reduced to cutoff. The high plate voltage light the neon lamp and provides the second tube wit a positive grid voltage. Therefore this tube conducts.

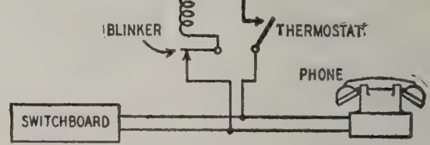
The change-over from conduction to cutoff i abrupt because the neon lamp strikes at a definit potential. The other parts of the circuit are no critical. It is only necessary that the input puls exceed a certain minimum value.

This circuit can be used as an improved puls counter or as an electronic switch.

AUTOMATIC FIRE ALARM

Patent No. 2,439,502
Thomas J. Tate, Talladega, Ala.

A thermostat is used in this invention to au tomatically sound a fire alarm and summon aid The alarm may be sent over telephone wires t the central office or may be sounded at th switchboard of a hotel or apartment house There is no interference with normal use of th telephone lines.



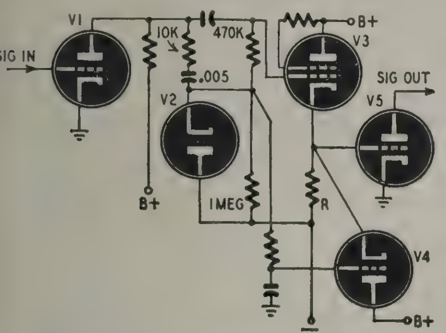
The only parts needed are a thermostat an a blinker. The thermostat is adjusted to clos the circuit at about 135° F. When a fire break out its contacts close and the blinker send periodic signals ove the wires. At th other end of the lin a light goes on an off or a gong sound to indicate where th fire has broken out.

For greater safet two thermostat cir cuits may be connect ed to the lines.

VIDEO AMPLIFIER

Patent No. 2,441,880
Elmer Dudley Goodale, Bayside, L. I.
ınd Vernon J. Duke, Rockville Centre, N. Y.
(assigned to Radio Corp. of America)

A video channel amplifies only the a.c. com- ponent of picture signals. The d.c. must be re- nserted in the output. A diode tube rectifies the



ulses and provides the d.c. for correct back- round brilliance.

The d.c. component must be kept fairly con- tant, especially at the transmitter end. If the ideo amplifier feeds into a grid-modulated power mplifier this may be difficult. As the grid bias aries it causes change in the picture background. 'his change can be avoided by adding a compen- ating tube.

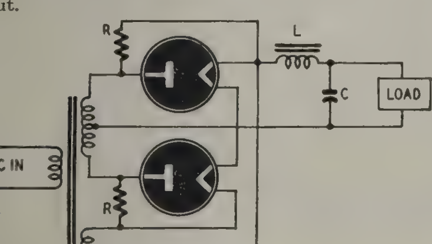
Only the a.c. component is amplified by V1. 'his voltage is rectified by V2. The cathode con- enser of V2 becomes charged to the peak voltage nd gradually discharges through the resistor etwork. This d.c. voltage is applied to the grid f V3, a cathode follower. From here it goes to he grid of the power amplifier V5.

The grid current of V5 may change with dif- erent values of excitation. This tends to vary rid bias on the tube. Compensating tube V4 is onnected across the cathode load of V3 to pre- ent this. When V5 grid current increases through R) it results in greater negative voltage cross R. This makes the cathode of V4 more egative and therefore increases plate current f the tube. Note that this current also flows ırough R but in the opposite direction. The mu- ıal conductance of V4 may be adjusted to make ıe two opposite currents equal. Then the aver- ge drop across R remains constant and cannot ffect the average brilliance of the picture back- round.

VOLTAGE REGULATOR

Patent No. 2,439,938
Reuben Lee, Catonsville, and
Charles K. Hooper, Shipley Heights, Md.
(assigned to Westinghouse Elec. Corp.)

Even in a well-designed power supply the reg- lation tends to become poor at low current rains. These inventors find that the sharp change voltage occurs when the harmonic compo- ents become larger than the average or d.c. out- ıt.



The characteristic curve becomes more nearly raight if the d.c. through the load always mains larger than the harmonics. This may assured by adding a conventional bleeder ross the load. Chokes large enough to pass e combined load and bleeder currents are re- ired. A more efficient solution is to add re- stors before the chokes.

A full-wave power supply requires two re- stors. For highest efficiency each should be ual to Σ7.6fL—0.239/fC, with f in cycles, L henries, and C in farads.

Dry rectifiers such as selenium permit cur- nt flow in both directions to some extent. In any cases the leakage may be equal to or rger than the above value. Therefore there is need for the added resistors.

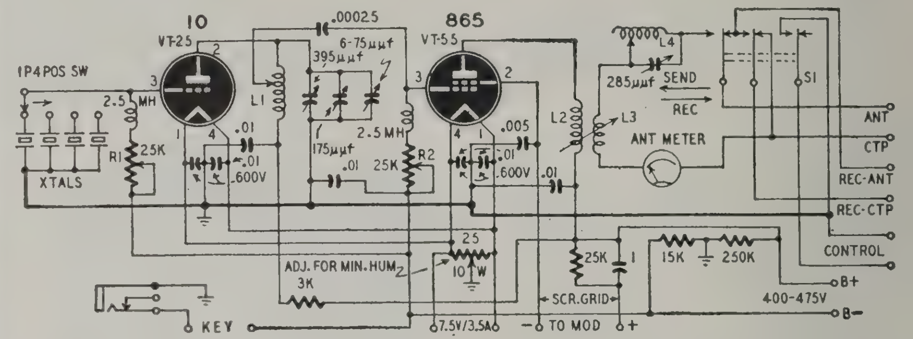
CONVERTING THE SCR-178 AND -179

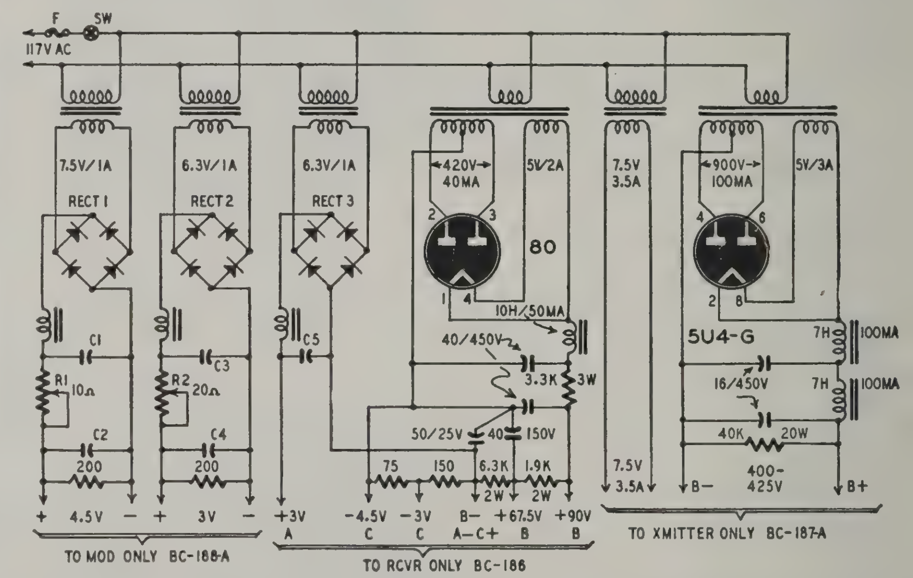
? *I have an SCR-178 radio set consisting of a BC-186 receiver, BC-187 transmitter, and BC-188 modulator. Please modify the transmitter diagram for use with a.c. on the filaments and crystals in the oscillator circuit. I also want a diagram of an a.c. power supply for the entire set. Can I alter the tuning range (2.4-3.7 mc) to 3.5-4 and 7-7.3 mc?—B. M. McN., Sydney, Nova Scotia.*

A. The transmitter circuit has been revised, and a power supply is shown. Separate d.c. supplies provide bias and filament voltages for modulator and receiver. Rect. 1, Rect. 2, and Rect. 3 are fullwave rectifiers that deliver about 6 volts d.c. at 300 ma or more. They may be Mallory type 1B12R or equivalent. The chokes in these circuits should carry 300 ma, and their d.c. resistance should be 4 ohms or less. The inductance should be .02 henry or more. C1, C2, C3, C4, and C5 are 6-volt electrolytics with capacitances of 500 μf or more.

You may raise the tuning range of the transmitter to 4 mc by removing a few turns from L1 and L2. For 40 meters, remove about half the turns from L1 and L2. Vary the position of the grid tap on L1 and the number of turns on L3 and L4 for best results. Adjust R1 and R2 for correct bias on the VT-25 and the VT-55. Do not attempt to double in the final or oscillator.

Ready-made plug-in coils can be used in the receiver if they can be made to fit the coil sockets. If not, you can wind them, using standard data for 140-μμf tuning condensers.





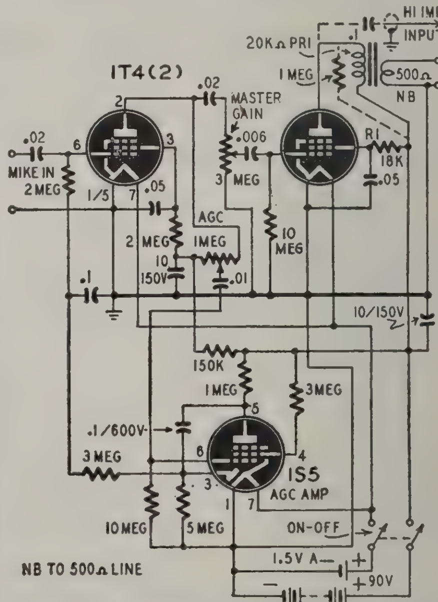
PREAMPLIFIER WITH A.G.C.

? *Please print a circuit of a battery-powered microphone preamplifier and include automatic gain control. I would like to use 1S5's throughout, if possible. —N.F.W., East Alton, Ill.*

A. Here is a circuit of a microphone preamplifier with a.g.c. Remote-cutoff tubes work best in a.g.c. circuits so 1T4's or equivalents are desirable. A 1S5 is the a.g.c. amplifier and rectifier. Adjust the control in the plate circuit of the first 1T4 for satisfactory operation.

If the preamplifier is some distance from the main amplifier, use a plate-to-line transformer as shown in the circuit. If the two units are close together, you can use capacitive coupling as shown by broken lines. Replace the transformer with a 1-megohm resistor in the plate circuit and change R1 to 2 megohms. Connect the plate of the 1T4 to the high-

impedance input terminal of the amplifier through shielded cable.



Question Box queries will be answered by mail and those of general interest will be printed in the magazine. A fee of $1.00 will be charged for questions requiring no research or schematics. Write for estimates on questions requiring diagrams or considerable research. Be sure to give *full specifications and details on the application.* Six to 8 weeks is required to draw up answers involving large schematics or research.

. . . . CONDENSER SHORTS

If a small set with a loop antenna lacks sensitivity and image rejection even after being properly aligned, check the variable condenser for a high-resistance short which may be loading the antenna. Remove the condenser, clean it with carbon tetrachloride, and bake it in an oven to remove moisture. Don't heat it too much.

JOE FIEDERER,
Worcester, N. Y.

. . . . OLDSMOBILE 982375

When installed in the automobile this set would cut out after about a half hour. On the bench it would sometimes play for a whole day without the slightest difficulty.

The trouble was in the oscillator grid coil. Loose turns on the ground end were rubbing against each other and shorting out. The winding cannot be seen but the trouble was detected with an ohmmeter.

I removed the winding, rewound the loose turns, and heated the coil to drive out moisture. Then I gave it a coat of speaker cement. The set then worked perfectly.

C. W. TEWS,
Milwaukee, Wis.

RADIO-CRAFT offers a 1-year subscription or $3.50 for *television Technotes* describing troubles in popular TV receivers and telling how the problems were solved.

. . . . ARLINGTON MODEL 7J7

The set played intermittently and distorted badly. The distortion remained after the defective a.v.c. filter and audio coupling capacitors were replaced. Disconnecting and resoldering the leads from the output transformer to the speaker voice coil cured the trouble. Evidently the original connection was faulty.

C. W. TEWS,
Milwaukee, Wis.

. . . . TUNING CAPACITORS

A dirty tuning capacitor is a frequent cause of noise and erratic operation. An oil can filled with carbon tetrachloride helps clean high-resistance bearings.

To clean dirt from between the plates, blow it out and use pipe cleaners or a visiting card moistened in carbon tetrachloride. Look through the plates with a light behind them to find metal filings or steel wool. If plates are touching, place a calling card or a plastic speaker shim between each set of plates until the set operates.

Small metal chips can usually be removed by burning them out. Connect the high voltage momentarily across the plates. Do not do this if the plates themselves are touching each other.

H. A. NICKERSON,
Dorchester, Mass.

(Better disconnect the coil first.—*Ed*)

CHECKING OSCILLATORS

Another receiver can be used to find out whether the local oscillator in an apparently dead receiver is operating or not.

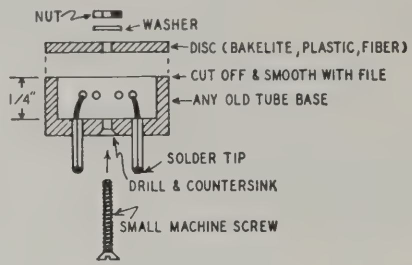
Tune the good receiver to a frequency equal to the dead receiver's i.f. plus 500 kc and the dead receiver to about 500 kc. A beat note should be heard in the good receiver.

The two sets may have to be coupled fairly closely if the dead one is well shielded. It may be necessary to use capacitive coupling between the oscillator and the antenna of the good set. A 2-turn gimmick around the oscillator grid or anode may be used to couple to the antenna.

THOS. P. MOTTLEY,
Ocean Grove, N. J.

TUBE BASE CONNECTOR

Flat cable connectors can be made easily from old tubes. Cut off the base leaving about ¼-inch inside clearance.



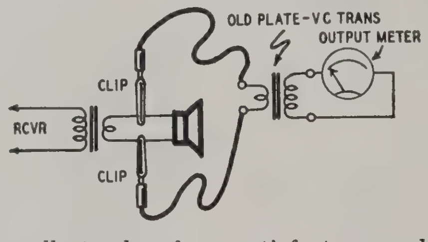
Cut out a plastic disc of about the same diameter as the tube base.

Drill holes for the cable in the side of the base. Connect the wires to the tube prongs, then place the plastic disc over the tube base, as the drawing shows, and fasten it in place with a flat-headed screw run through a hole drilled in the bottom of the base. After the nut is tightened, file the edges of the disc flush with the tube base.

William F. Wendt,
Napa Calif.

MEASURING OUTPUT

When aligning a receiver, the voice coil is the logical place to connect the output meter because of accessibility. The voltage at this point, however, is



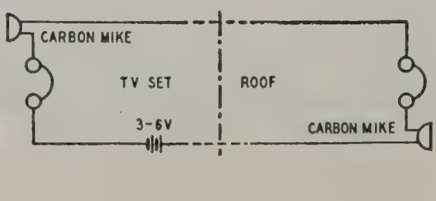
usually too low for a satisfactory reading.

Any old output transformer will make a useful shop tool to obtain a higher voltage. Equip the secondary (4-8 ohms impedance) with a pair of leads ending in alligator clips. To make output measurements, connect these clip leads across the set's voice coil and clip the voltmeter leads to the plate winding of the old output transformer. The transformer will step up the set's output voltage and a very good meter reading will be obtained.

Albert Loisch,
Darby, Pa.

TV INSTALLATION

For installing television antennas, it is essential to have communication between the man on the roof and the man watching the screen to determine when the image is satisfactory. A very simple system requires only two pairs of magnetic headsets two carbon microphones, and a 4½-volt battery.



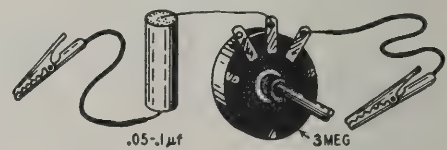
Connect one microphone, one headset, and the battery in series at the receiver location. Run a 2-wire line (anything will do, even lamp cord) to the roof. Across the roof end of the line connect the other headset and microphone in series.

Depending on the components at hand, a smaller or slightly larger battery may be desirable. With ordinary 2,000-ohm headsets and surplus oxygen-mask microphones, four and one-half volts worked well.

Richard Henry,
New York, N. Y.

INTERMITTENT CHECKER

Many intermittents are caused by capacitors which open when normal voltages are applied to them, but which check O.K. on a condenser tester. To locate one of these, it is usual to wait



until the receiver stops working, then shunt a good capacitor across the suspected one. Often the sudden charging of the good capacitor is enough to start the set going again.

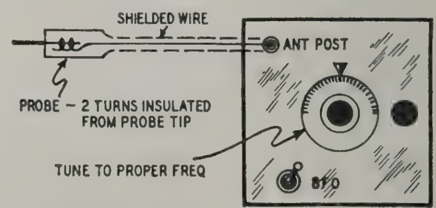
To reduce the suddenness of the charging, place a 3-megohm potentiometer in series with the good capacitor. Set the potentiometer for maximum resistance, then shunt the combination across the suspected capacitor. Slowly rotate the potentiometer shaft to minimum resistance. If, somewhere along the line, the set starts to operate, the chances are good that the suspected capacitor was the bad one.

Russell Swanfelt,
Fort Wayne, Ind.

(No gadget can be depended on for consistent results with intermittents, but this one is simple to make and should repay the effort required—*Editor*)

SIG-TRACER RECEIVER

Some of the surplus receivers, especially the low-frequency models, can be used as signal tracers. The receiver should cover the r.f., i.f., and local os-



cillator frequencies of the receiver under test and should have a c.w. oscillator. It should be one of the well-shielded varieties.

Shield the antenna post and attach a probe to it with a short shielded cable, as shown in the drawing. It may be necessary to replace the antenna terminal with a jack for better shielding.

George H. Hague,
Fall River, Mass.

TIP JACKS

When tip jacks are needed try the base pins of old tubes. Break up the tube bases with a hammer, being careful not to crush the pins. Heat each and blow the solder from inside it. Several different-sized jacks can be made from different base pins.

L. E. KLINGBERG,
Inglewood, Calif.

FM ALIGNMENT

FM ratio detectors sometimes are jarred slightly out of alignment by a rough trip from the factory. To align them I turn on the motor of my car, which is less than 50 feet from the antenna, tune in a weak station, then adjust the ratio-detector trimmers to cancel out the ignition-noise interference.

This method will not work with sets that have limiters.

ROBERT C. GREEN,
Hyattsville, Md.

PILOT LIGHT LONGEVITY

To avoid the bother and expense of changing pilot lights in a.c. receivers and amplifiers, unsolder the leads of the light socket from the 6.3-volt power transformer winding and hook them across the 5-volt rectifier winding. Reducing the voltage applied to the bulb to 5 volts will about triple its life.

Be sure that the socket is thoroughly insulated (both contacts) since the light will be at high voltage to ground. Lack of care in this respect may cause shorting of the high-voltage supply or severe shock.

If no 5-volt winding is available, a resistor of about 10 ohms in series with the lamp will accomplish the same purpose. The brightness of the light does not decrease noticeably with either method.

ROBERT D. CARLEN,
Brooklyn, N. Y.

ANTENNA COUPLING

The performance of some receivers, both t.r.f. and superheterodyne, can be improved by winding the insulated antenna lead around the grid lead of the input tube several times before connecting it to the antenna post. This adds capacitive coupling to the inductive coupling. Capacitive coupling is built into many sets. Those that don't have it are improved by this trick.

FRANK BODINE, W4JVZ,
Ft. Wayne, Ind.

RADIO-CONTROLLED BEAM

The BC-357, a surplus marker-beacon receiver, has a relay in the output circuit. It was originally designed so that an incoming signal would close the relay and light a lamp.

The receiver can be used to control the rotation of a beam antenna located at some distance from the shack. Shunt the two tuned circuits with capacitors made of twisted wire to lower the frequency from the original 75 mc to the upper portion of the 6-meter band. Place the receiver at the antenna location with the relay contacts in series with the beam-rotator motor.

To rotate the beam, switch the transmitter to the receiver's frequency and key it until the beam is pointing in the right direction. Then switch the transmitter back to the operating frequency and go on the air as usual.

This receiver can, of course, be used for other types of radio-controlled devices.

A. R. GREEN,
Fort Worth, Tex.

(A 1-tube 6-meter control transmitter might be built especially for operating the antenna. This would save the trouble of retuning the main transmitter and would permit operation of 10- and 20-meter beams.—*Editor*)

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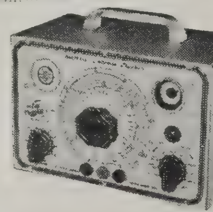

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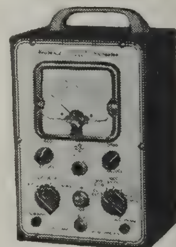

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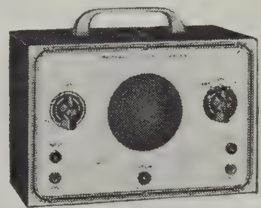

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Reduces service time and greatly increases profits of any service shop. Uses crystal diode to follow signal from antenna to speaker. Locates faults immediately. Internal amplifier available for speaker testing and internal speaker available for amplifier testing. Connection for VTVM on panel allows visual tracing and gain measurements. Also tests phonograph pickups, microphones, PA systems, etc. Frequency range to 200 Mc. Complete ready to assemble. 110V 60 cycle transformer operated. Supplied with 3 tubes, diode probe, 2 color panel, all other parts. Easy to assemble, detailed blueprints and instructions.

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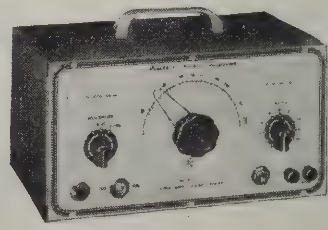
The square wave is of excellent shape between 100 and 5,000 cycles giving adequate range for all studio, FM and television amplifier testing.

Either sine or square wave available instantly at a toggle switch. Approximately 25V of sine AC available at 50,000 ohm output impedance. Output ± 1 db. from 20 to 20,000 cycles. Nothing else to buy. All metal parts are punched, formed and cadmium plated. Complete with tubes, all parts, detailed blueprints and instructions.

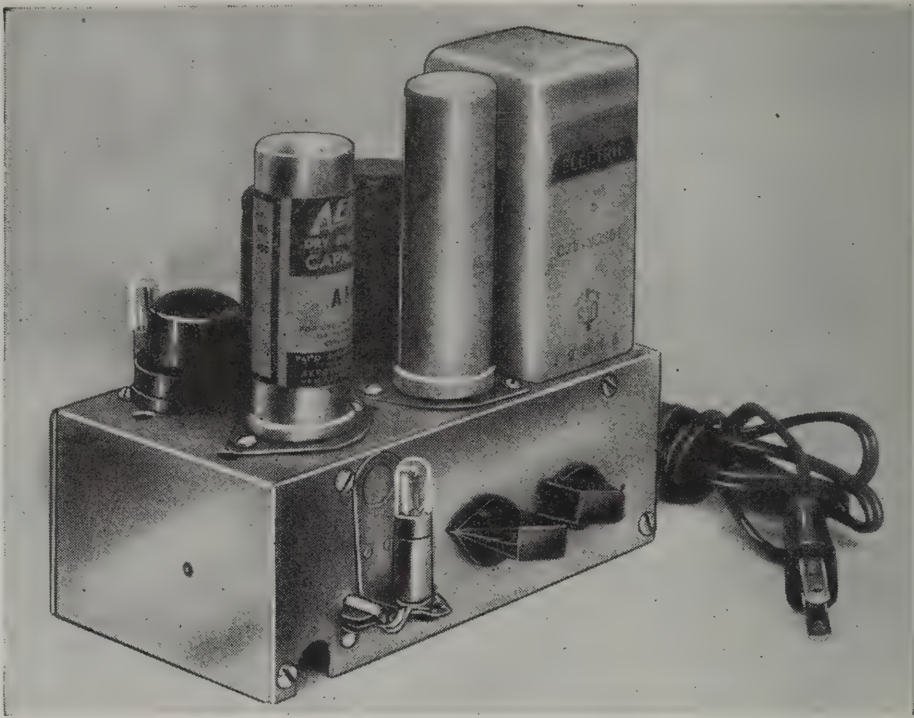
$34.50

Shipping Wt., 13 lbs.



The HEATH COMPANY

DEPT. C . . . BENTON HARBOR, MICHIGAN



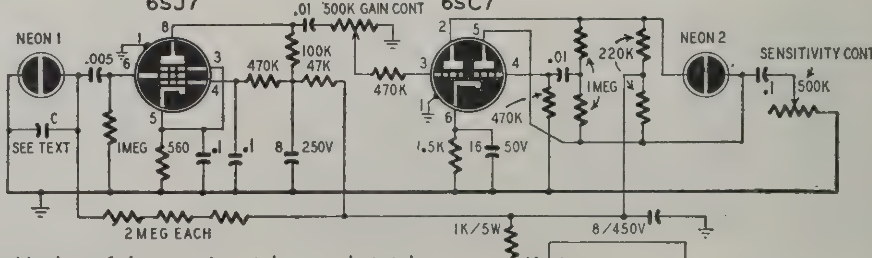
The photo-sensitive lamp is the one beside the knob, which acts as a sensitivity control.

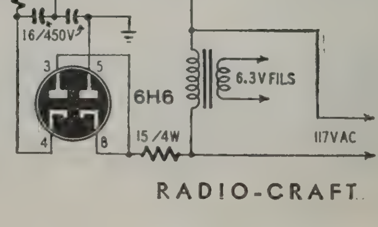
Neon Lamp as Phototube

By ROBERT JONQUET

THE average radio and electronic experimenter is not aware that neon glow lamps have photoelectric characteristics that make them sensitive to variations in light intensity. Under some conditions they are surprisingly sensitive and can be made to work like the familiar relaxation oscillator when supplied with *a.c.* instead of d.c.

The diagram shows a neon lamp Neon 1 connected as a standard relaxation oscillator operating between 500 and 700 cycles and feeding into a 2-stage voltage amplifier consisting of a 6SJ7 and one half of a 6SC7. The other half of the 6SC7 is a phase inverter. A gain control is in the grid circuit of the





Hookup of the experimental neon phototube.

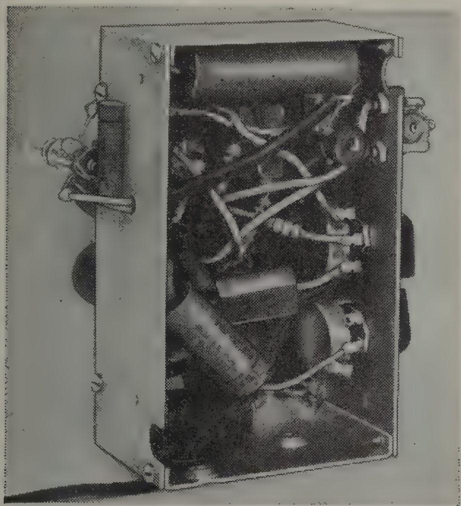
amplifier section of the 6SC7. The 470,000-ohm resistor in series with its grid prevents it being overloaded by the 6SJ7.

Note that the control and screen grid connections are reversed. This connection is necessary for a stable circuit.

The photosensitive lamp Neon 2 is connected directly across the output of the 6SC7. Blocking condensers may be used, if desired, to prove that a.c. rather than d.c. is required for proper operation of Neon 2. The sensitivity of this circuit is controlled by the 500,000-ohm resistor and 0.1-μf condenser in series between the phase-inverter plate and ground.

The operating voltage is supplied by a 6H6 connected as a voltage doubler. A pair of selenium rectifiers can be used instead to give a higher and more stable voltage.

When constructing this circuit, duplicate as closely as practical all parts values specified on the diagram. It may be necessary to experiment with values of condenser C. This should be adjusted



The wiring below the chassis is noncritical.

to cause Neon 1 to oscillate at between 500 and 700 cycles. Try values between .0007-µf and .003-µf. Almost any neon glow lamp may be used for Neon 1. Neon 2 may be a type NE3, NE51, or any other 1/25-watt glow lamp *without* a resistor in its base.

This unit is simple to operate. Make sure Neon 1 is oscillating by connecting a pair of phones across Neon 2 through blocking condensers or by noting a slight glow on one electrode of Neon 2. When you are sure of proper operation this far disconnect the phones, turn the gain control all the way up, and adjust the sensitivity control for full resistance. This should make both electrodes of Neon 2 glow brightly. Back off the sensitivity control about three-quarters and decrease the gain until one electrode goes out completely.

Now adjust the sensitivity control until the lamp begins to flash slowly. Decrease the gain until the lamp just goes out. At this point, Neon 2 is most sensitive to light changes. Focus light rays on the lamp, and it will begin to flash again. If it fails to do so, a slight adjustment of the gain or sensitivity controls, or of both, should produce the desired results.

Placing phones across the lamp, you will be able to hear the frequency of the pulses increase or decrease as the light source is brought nearer or moved away from the lamp. When phones are connected across the lamp, it may be necessary to readjust the controls slightly.

In its present state, this device is simply an interesting experiment. However, it offers a challenge to experimenters who may be able to put the circuit to practical use. The writer is interested in hearing of any progress that you may make toward this goal.

Small-Space Metal Locator

HERE is an efficient metal locator which can be made very small, especially if hearing-aid batteries are used. No cabinet dimensions are given, since each constructor will use his ingenuity to put the electronic parts in as small a box as possible.

As the diagram (Fig. 1) shows, 3A5's are used in both transmitting and receiving sections. The transmitter uses a Hartley oscillator. The transmitting coil L1 is the exploring device and is located at the lower end of the handle, Fig. 2. It is wound around the edges of a 3-inch thick piece of wood 18 inches square. Use 20 turns of No. 18 bell wire or any other wire larger than No. 24. Experiment for the best place for the tap.

The long handle (see Fig. 2) is a 4½-foot of length of 2 x 2. The cabinet containing the tubes and electronic components other than L1 is mounted at the top.

The two sections of the transmitting 3A5 are paralleled. The plates of the receiving tube are paralleled but the grids are not. The antenna may be a 1-or 2-foot length of wire wrapped around the cabinet.

The tuning capacitors C1 and C2 are 100-µµf air padders. They are screwdriver adjusted and are less affected by vibration than standard mica padders.

The receiving coil L2 is a standard broadcast-band r.f. coil with a tickler winding added. Vary the number of turns for best results. If several coils are in the junk box, experiment to find the best one.

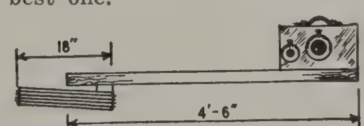


Fig. 2—Place handle at the point of balance.

To adjust the metal locator, open the antenna trimmer about half way, then adjust both tuning capacitors until the loudest signal is heard in the phones. The 50,000-ohm potentiometer will provide some volume control. Tune the antenna trimmer until a clicking sound appears in the headphones. In exploring, a change in sound usually indicates the presence of metal.—JOHN HAYNES

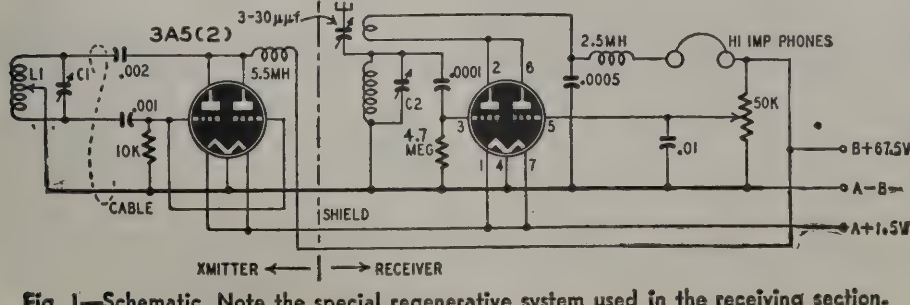


Fig. 1—Schematic. Note the special regenerative system used in the receiving section.

Communications T.R.F.

By T. W. DRESSER

SINCE short waves were first used for communication, controversy has raged over the relative merits of the t.r.f. set and the superheterodyne. The prime bone of contention has been the signal-to-noise ratio. The t.r.f. enthusiast swears that he gets a signal as strong as, but considerably clearer than, the superheterodyne user; while the latter is equally emphatic that he can pick up signals the other fellow can't even hear.

Manufacturers of receivers for the amateur have, with few exceptions, adhered religiously to superhets; and it must be admitted they have turned out excellent jobs. But one point about their products makes the t.r.f. user wrinkle his nose—they have all had to use noise-limiting circuits.

The suggestion put forth by some that the t.r.f. as a short-wave receiver is finished is difficult to justify. On the whole, its advantages far outweigh its disadvantages. Its simplicity in construction and operation lends itself to sturdiness; it is not prone to alignment troubles, and—perhaps its outstanding point—it has very low noise level. Its principal fault is poor selectivity, inability to separate stations 10 kc apart. But there is no reason why such separation should not be achieved in a t.r.f.

The advocates of the superhet claim that it is both selective and sensitive if the design is good; and, of course, they are correct. But a great deal depends upon the design, particularly upon the choice of the intermediate frequency. If the latter is low, in the 450-kc region, image suppression is poor. If it is high, 1600 kc to 3 mc, there is a strong risk that the i.f.'s will pick up signals at or close to the fundamental frequency. Moreover the gain at these higher frequencies is relatively poor, and i.f. stages may have to be added to compensate for the loss of gain. This further increases the cost and the noise level. It is another vicious cycle.

The superregenerative receiver is hardly worth mentioning. It is extremely noisy and decidedly unselective.

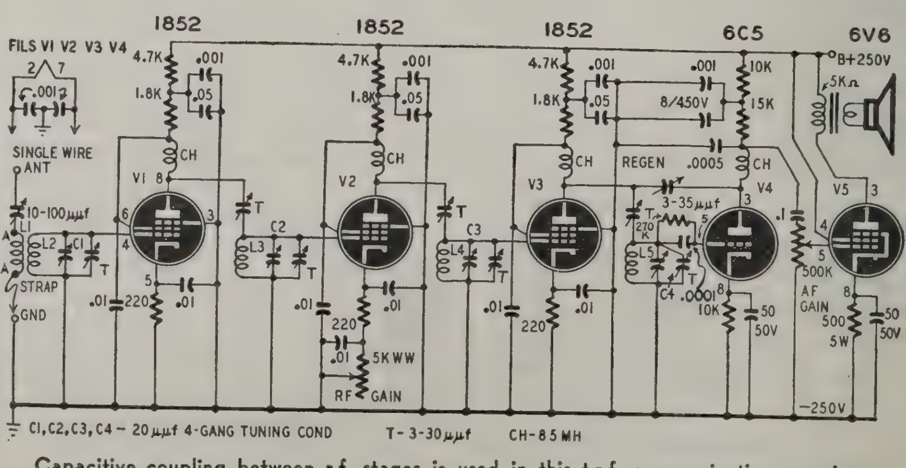
The t.r.f. set shown in the diagram uses the best of the modern high-gain r.f. tubes to improve the sensitivity. It incorporates all good qualities of the t.r.f. Its performance was judged against that of a superhet built some time ago, on which performance figures were available.

In designing the circuit selectivity was a first requirement, so a minimum of two (preferably three or four) tuned circuits was desirable. Shielding had to be adequate, and there had to be ample decoupling. The detector had to be capable of handling a large signal without distortion as no a.v.c. was to be used.

The circuit, although not highly original, makes full use of the high gain available from modern 1852 tubes. Three of them are used in the r.f. stages with somewhat unorthodox decoupling. A 6C5 acts as a grid-leak detector and a 6V6 is the output tube. Plate and heater circuits are well filtered, making for low hum and stability. Each stage is unusually well shielded from its neighbors both above and below the chassis deck. The r.f. gain control is in the cathode of the second stage.

Tuned grid circuits are used throughout and the coupling capacitors are variable. Alignment, therefore, resolves itself into adjusting for maximum signal these coupling capacitors and the trimmers on the 4-gang tuning capacitor. The antenna capacitor is used with single wire antennas. In the first model plug-in coils were used, but switched coils are more convenient if there is really effective shielding between stages.

* Bradford, England



Capacitive coupling between r.f. stages is used in this t.r.f. communications receiver.

Assembled on a 12 x 8 x 2½-inch aluminum chassis, the receiver is good looking, and it has exceptional sensitivity, a noise level that is negligible, and selectivity that is outstanding for a t.r.f. Given a good layout with regard to the high gain involved, short wiring, and good solid ground connections, it will provide excellent performance. Here in Britain, with 10 feet of uninsulated wire hanging 6 inches from a brick wall and surrounded by high hills, it has received Australia and Argentine consistently at R8. As for the c.w. hound, use of the regeneration control will give him all the code he wants, with the r.f. stages effectively preventing any radiation from the antenna.

COIL TABLE

Wave length (meters)	L1 (turns)	L2 (turns)	Wire size
7-18	2¼	5½	21
17-36	3¼	13	21
34-78	7	24½	21
75-150	11	52	23
145-250	13	111	28
240-575	20	230	30

All forms 1 inch in diameter. All coils close-wound.

ELECTRON-RAY TESTER

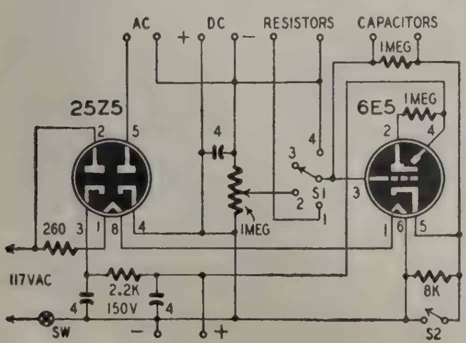
The diagram shows a tester using a 6E5 indicator for measuring a.c. and d.c. voltages and detecting bad capacitors and resistors.

To check d.c. volts, connect the voltage to the d.c. terminals, set S1 to position 2, and adjust the potentiometer for zero shadow. If the potentiometer dial has previously been calibrated with various voltages, it will read the value applied. The same holds true for a.c., which is rectified by one of the 25Z5 diodes.

To check resistors open S2. Bias for the 6E5 is developed by the 8,000-ohm cathode resistor. Switch S1 to position 1 and connect the resistor across the terminals. If it is good, it will act as a grid leak and the eye will close. If it is open, the grid will float and shadow angle will be maximum.

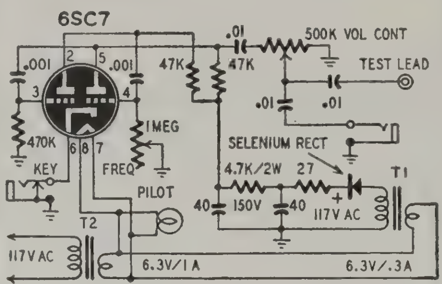
To check capacitors open S2, switch to position 4, and place the capacitor across the terminals. The 1-megohm terminal resistor and the potentiometer act as a voltage-divider across the cathode-resistor voltage, with the grid connected to the center. Now switch to position 3. If the capacitor is good, its charge will tend to hold the shadow angle small. If it is open or shorted, the shadow angle will enlarge to maximum.

RUSSELL BEANE,
Tionesta, Pa.



CODE OSCILLATOR

Here is a multivibrator oscillator which can be used for code practice and as a signal source for testing amplifiers. The key is connected in series with the 6SC7 cathode. A phone jack is provided for headphone output and a pin jack takes a test lead.



A selenium rectifier is used. T2 furnishes 6.3 volts for the 6SC7 filament and the pilot light. It is also connected to T1, another filament transformer, which is operated in reverse to produce 117 volts for the rectifier. This isolates the power supply from the a.c. line, a good idea in view of the fact that the exposed metal of the key would otherwise be connected directly to one side of the line.

The frequency can be controlled within limits by the 1-megohm potentiometer. The oscillator will not chirp, even with very fast keying.

W. A. M. Wood, VE4MW,
Winnipeg, Canada

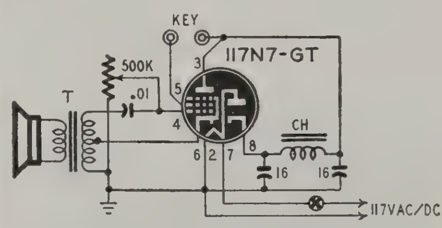
CODE OSCILLATOR

This 1-tube code oscillator gives loudspeaker output. T may be almost any center-tapped output transformer. Ch can be any filter choke or it may be replaced by a resistor (experiment for value).

Since the key contacts are connected to the high voltage use insulation or one of the surplus keys which are entirely enclosed.

The potentiometer will vary the tone as well as the volume.

Woodrow V. Ryder,
Red Hook, N. Y.



SET ALIGNMENT

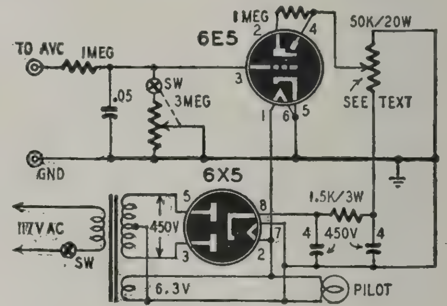
A 6E5 electron-ray tube can be used as an indicator for aligning sets with a.v.c.

A unit like the one shown in the diagram can be built in a small metal box. Use a toggle switch in the transformer primary circuit. The grid switch is on the 3-megohm volume control. Adjust the tap on the 50,000-ohm bleeder until the power-supply output is 250 volts.

To align a receiver, supply it with an unmodulated signal and connect the indicator leads to the a.v.c. line and the set's ground. Adjust the trimmers for maximum closure of the shadow on the 6E5 screen.

If the eye closes too soon, turn the potentiometer to close the grid switch and adjust it for the desired shadow angle.

Ted R. Parks,
Salem, Ore.



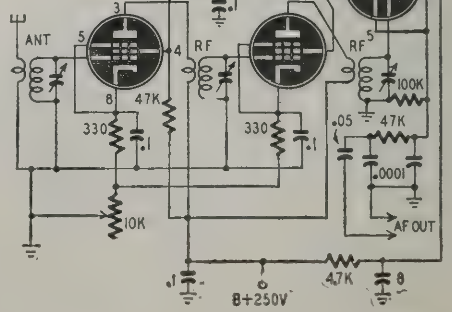
> Radio-Craft welcomes new and original radio or electronic circuits. Hookups which show no advance on or advantages over previously published circuits are not interesting to our readers. Send in your latest hookups and receive a 1-year subscription to Radio-Craft or $3.50 for each contribution accepted. Pencil diagrams—with short descriptions of the circuit—are acceptable if clearly drawn on a good-sized sheet of paper.

T.R.F. TUNER

The diagram shows a high fidelity t.r.f. tuner described originally in *Radio and Hobbies*, an Australian magazine.

Standard coils are used with a 3-gang 365-μμf tuning capacitor.

To align the tuner, tune in a station toward the high end of the band (or a signal from a test oscillator) and adjust trimmers for maximum output. If a commercial calibrated dial is being used, peak the trimmers and note the dial calibration. If it is off, move the dial slightly toward the correct mark and realign. Keep this up until peak output occurs at the proper marking. As a check on the trimmer settings tune to one side of the carrier and peak them on the noise. If iron-core coils are used, they can be peaked on a low-frequency station, then the trimmers rechecked on



a high-frequency station. Very little tracking trouble will be had.

The 6J7 is an infinite-impedance detector. The tube operates on a non-linear portion of its E_g-I_p curve, as in a plate detector, but output is taken from the cathode circuit. This gives negative feedback reducing distortion.

RADIO-CONTROL UNIT

The transmitter for this radio-control unit uses the spark-gap discharge principle. It is shown in Fig. 1. An old Ford spark coil steps up the voltage from a 6-volt battery to a high value; the high voltage discharges as a spark across the gap between the two 1-inch-diameter brass balls. These can be salvaged from an old brass bedstead or curtain-rod assemblies.

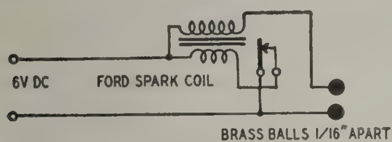


Fig. 1—Activator of the radio control tube.

Fig. 2 is the receiver diagram. The antenna is a length of copper tubing bent to form almost a complete circle 12 inches in diameter. A 1.5-volt flashlight battery biases the 2051 gas tetrode. When the signal is picked up, the tube is triggered and the relay is energized.

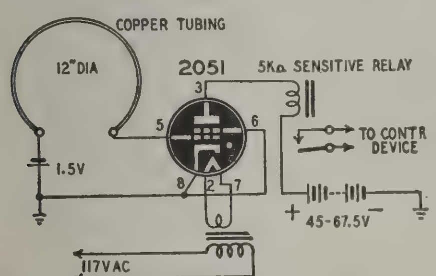


Fig. 2—Control tube is a small thyratron.

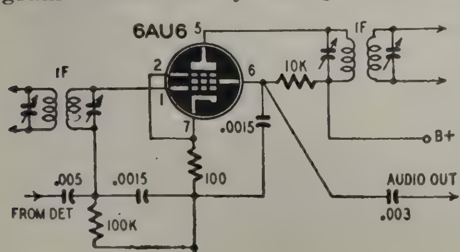
Anything can be controlled if it is connected to the relay contacts. Control is reliable, however, only if the transmitter and receiver are no more than 12 feet apart. I use the gadget to open my garage doors without getting out of the car. The transmitter creates radio interference for a greater distance so should be operated as little as possible.

MELVIN YOUNGMAN,
Oak Park, Ill.

NOVEL REFLEX CIRCUIT

In the conventional reflex amplifier a resistor is connected between B-plus and the plate as an audio load. This causes a loss of plate voltage and a reduction in r.f. amplification.

The reflex circuit shown in the diagram avoids this by taking the audio



from across the screen dropping resistor, leaving the plate connected to B-plus through the i.f. transformer, just as in ordinary non-reflex circuits.

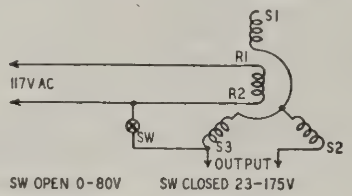
The arrangement can be adapted to almost any tube used in a reflex receiver.

R. A. CUNNINGHAM,
Newport, Ky.

(The idea is interesting. Gain may be lower, but with r.f. filtering, the audio could be carried through two stages.—*Editor)*

AUTOTRANSFORMER

A war surplus size 5 synchro makes an excellent adjustable autotransformer when connected as shown. With an input of 117 volts at 60 cycles, output can be varied smoothly from 0-80 volts or from 23-175 volts by turning the rotor. Five hundred watts can be handled intermittently or 150 watts continuously. A friction lock on the shaft or a worm-gear drive should be used.



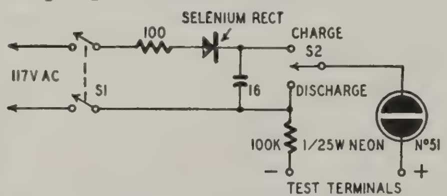
This autotransformer will be found especially useful in the service shop for boosting line voltage to intermittent sets to hasten the breakdown of the intermittent component.

G. A. DIXON,
San Pedro, Calif.

NEON TESTER

This simple tester will give a reliable report on the condition of capacitors and can be used for checking faulty receivers.

Place a capacitor across the test terminals. Close S1, then set S2 to CHARGE. A good capacitor will charge and this will be indicated by a flash of the neon lamp. Open S1 and set S2 to DISCHARGE.



A good capacitor will discharge and the lamp will flash again.

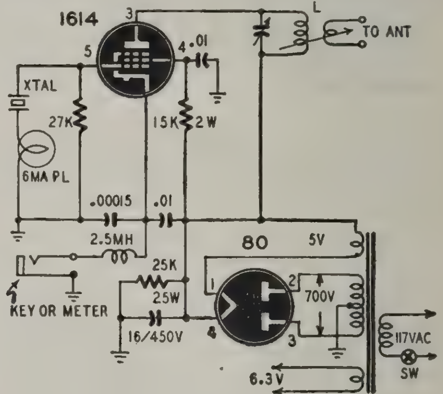
To check continuity, set S2 at CHARGE, close S1, and use the test terminals. To check for presence of a voltage, open S1, set S2 at DISCHARGE, and watch for the neon lamp to glow.

Since this instrument is connected direct to the line, it must be built into a box and only the leads from the neon tube and 100,000-ohm resistor brought out.

I. L. FRIEDMAN,
Brooklyn, N. Y.

1-TUBE TRANSMITTER

Here is a 1-tube 80- or 40-meter transmitter which is as simple to build and



operate as the usual 6L6 oscillator but which gives nearly 20 watts output.

Standard coils for 80 or 40 meters can be used for L and crystals for either band may be used. Operate straight-through, as doubling lowers the efficiency. Plug a 150-ma meter into the keying pack for tuning. Adjust antenna coupling for a maximum current of between 80 and 90 ma.

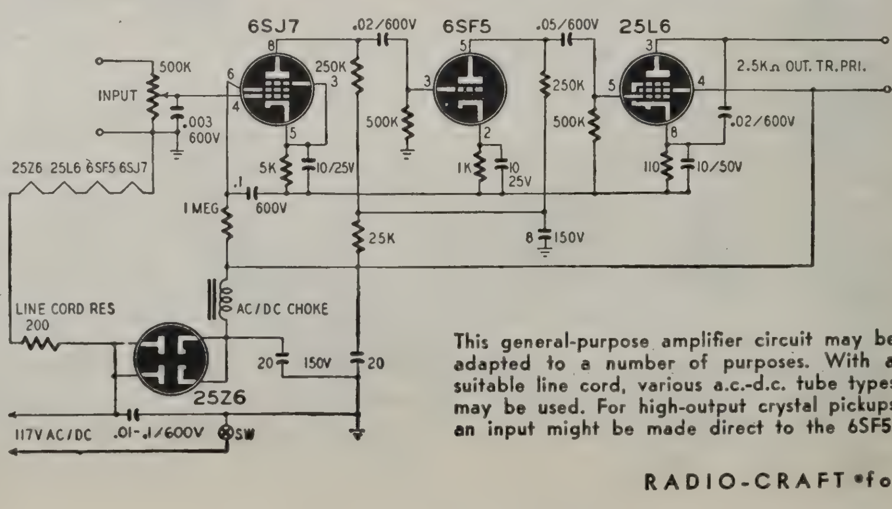
ROBERT FINK,
Cleveland, Ohio

A.C.-D.C. AMPLIFIER

Economy of cost is combined with good quality reproduction in this general-purpose a.c.-d.c. amplifier.

The first two stages provide sufficient amplification for a phono pickup or a microphone. A .003-μf condenser from the control grid of the 6SJ7 to ground filters out any needle scratch that may be present when records are played through the amplifier. Decoupling is provided by a 25,000-ohm resistor and 8-μf condenser in the plate lead of the input tubes.

LEON POLLARD,
Dorchester, Mass.



This general-purpose amplifier circuit may be adapted to a number of purposes. With a suitable line cord, various a.c.-d.c. tube types may be used. For high-output crystal pickups an input might be made direct to the 6SF5.

SMALLEST B-BATTERY

Courtesy Olin Industries Ltd.

Individual cells of new B-battery interlock automatically to make electrical connections, eliminating 91% of soldering. Electrodes are thin carbon-coated zinc plates which fit the square windows seen in center of sections.

Mobile communication needs have grown so much that the FCC last month proposed to separate the present automobile and truck telephone service into three new classes, each with its own frequency band.

The three classes would be: land transportation—busses, trucks, trains, and taxicabs; domestic public service—common-carrier service for the general public; and industrial service—delivery and pickup trucks, doctors' cars, and ambulances.

The proposed new services consolidate a number of present services, reduce overlap between them, and increase the number of businesses eligible to use radio.

Radio Thirty-Five Years Ago

In Gernsback Publications

HUGO GERNSBACK

Founder

Modern Electrics	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Radio-Craft	1929
Short-Wave Craft	1930
Wireless Association of America	1908

Some of the larger libraries in the country still have copies of ELECTRICAL EXPERIMENTER on file for interested readers.

In September 1914
ELECTRICAL EXPERIMENTER

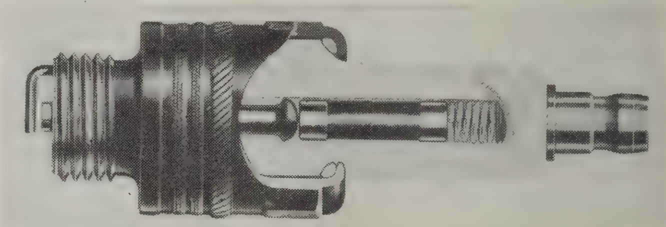
How to use the "Electro" Loose Coupler
Improved Buzzer Transmitter by *Frank H. Broome*
Aerial Mast Construction by *Charles Fitzgerald*
The Sayville, L. I., Wireless Station
Adjustable Condenser and 'Phone Switch by *Frank H. Broome*
A good Mineral Detector by *Ralph Humphrey*
Portable Wireless Station Tower
Automatic Tikker Receiver
New Pickard Crystal Detector Stand
Firing a Revolver by Radio Waves
200 Volt Radio Transformer

Scale models of television studios simplify planning. Transmitter is at rear, control console in foreground, and cameras at right in this picture. General Electric employees Jean Thater and Jane Reid inspect the model.

SPARK PLUG REDUCES INTERFERENCE

NOW that FM and television are gaining wide acceptance, high-frequency noise from automobile engines is becoming an important source of interference. A new spark plug developed by the Electric Auto-Lite Company contains a built-in resistor which is said to reduce noise radiation considerably.

The discharge at the gap of a spark plug consists of high-voltage, high-amperage damped oscillations of short duration followed by a non-oscillating discharge of much greater duration. The oscillatory discharge generates high frequencies of large amplitude. These cause serious radio interference.



As the cutaway photograph shows, the new plug has a built-in 10,000-ohm ceramic bonded carbon resistor between the "hot" terminal and one side of the spark gap. The resistor has a damping effect.

The damping reduces the duration of the oscillations and also restricts the oscillation to lower frequencies. The oscillation peaks are damped so effectively that radiation is kept below 35 millivolts per meter from 540 kc to 150 mc at 50 feet from the engine.

In addition to suppressing interference the new plug is said to reduce engine misfiring, help lubrication, and lengthen the life of pistons, rings, and cylinder walls.

BETATRONS IN FIGHT AGAINST CANCER

Betatrons will be used next year for cancer treatment for the first time, *Science Service* reported recently. The betatrons will produce 20-million-volt X-rays 20 times more powerful than those used heretofore. These X-rays can be concentrated on a point deep inside the patient's body with reduced danger of damage at the point where the rays enter the body. Lower-voltage rays have their maximum effect at the surface.

The betatron produces its X-rays by bombarding a platinum target with high-energy electrons.

When it was invented, its originator, Prof. Donald W. Kerst of the University of Illinois, pointed out its cancer-fighting possibilities. Research in this direction was delayed, however, by the war.

FM STATION LIST

THE response to our call for FM scouts has been extremely good. Mail has been arriving in large quantities and the letters have all been interesting. We expect that the reports from RADIO-CRAFT readers will be of definite importance to those who are gathering information about FM propagation on the 100-mc band because they upset any theories which might still exist about line-of-sight reception.

Sidney Padrick, of Avenal, California, for example, reports reception of KIMV, Hutchinson, Kansas; WKY-FM and KOCY-FM, Oklahoma City, Oklahoma; and KCMC-FM, Texarkana, Texas, among others. Signals were strong—and all the stations were from *1,200 to 1,400 miles away!* This was no laboratory experiment; a Meissner tuner was used with a Ward antenna. Although the antenna array included a reflector, rotating it had no effect.

Hayes Lyon, located in Austin, Texas, reports hearing KNX-FM, Hollywood, California, and WNDB, Daytona Beach, Florida, 1,200 and 1,000 miles away respectively. He used a Scott receiver *with the antenna built into the cabinet.* The signals faded in and out, being absolutely clear and noiseless at their best.

Another Scott owner, R. J. Marks of Norfolk, Virginia, reports reception of KOCY-FM, Oklahoma City, a distance of about 1,175 miles.

John A. Beckman of Jacksonville, Florida, reports frequent reception of WMIN-FM, St. Paul, Minnesota. He uses a Hallicrafters SX-43 with a half-wave doublet antenna cut for the 40-meter amateur band. Reception over this 1,190-mile path is best after 6 pm. The signal fades in and out at 5- to 10-minute intervals.

Several 1,000-mile reports came in. Roger E. Hammer of Elkton, Virginia, received WFAA and KIXL in Dallas, Texas, with a Westinghouse receiver and a folded dipole and reflector 30 feet above ground. Charles E. Brown in West Palm Beach, Florida, heard WFUV in New York City on a home-built receiver with an r.f. stage and three i.f. amplifiers.

Reception of WMIN-FM, St. Paul, Minnesota, was reported by S. B. Knapp of Baton Rouge, Louisiana. Mr. Knapp made a wire recording of the programs to prove his DX report.

Harold R. Vogt of Mountain Lake, Minnesota, writes that he heard WTPS-FM in New Orleans, Louisiana, with plenty of volume for a few minutes, after which the station faded out. The owner of Schmitz Radio in Staples, Minnesota, reports reception of WMAS-FM in Springfield, Massachusetts.

There were several long-distance reports on old-band (42-50-mc) FM. The ordinary skip-effect is known to be present on this band, which was one of the reasons for going over to the high band after the war. These reports were, therefore, excluded from our discussion.

We hope that all RADIO-CRAFT readers who own FM sets will continue to act as FM scouts and send in their reports on

any record long-distance FM reception.

When you write please include all the information you can think of. Especially important are: type of set; description of antenna; the type of country surrounding the receiving location—hilly, flat, etc.; signal strength of stations received, time of day, and giving us *airline* distance between your location and the transmitter.

FREQUENCY (MC)	CALL	LOCATION
44.1	W2XMN	Alpine, N. J.
89.1	WHSF	Wausau, Wis.
89.5	WSOU	So. Orange, N. J.
89.9	KCRW	Santa Monica, Calif.
89.9	WCTF	Chicago, Ill.
89.9	WHKW	Chilton, Wis.
90.1	KOKH	Oklahoma City, Okla.
90.1	KRVM	Eugene, Ore.
90.1	WABE	Atlanta, Ga.
90.3	WBOE	Cleveland, Ohio
90.3	WSHS	Floral Park, N. Y.
90.5	KWGS-FM	Tulsa, Okla.
90.5	WKAR-FM	E. Lansing, Mich.
90.7	WFUV	New York, N. Y.
90.7	WHAD	Delafield, Wis.
90.9	KOKU	Norman, Okla.
90.9	WDTR	Detroit, Mich.
90.9	WEHR	State College, Pa.
90.9	WFIU	Bloomington, Ind.
91.1	WBGO	Newark, N. J.
91.3	KCVN	Stockton, Calif.
91.3	WBKY	Lexington, Ky.
91.3	WOI-FM	Ames, Iowa
91.3	WTDS	Toledo, Ohio
91.3	WWCH	W. Chester, Pa.
91.5	KSLH	St. Louis, Mo.
91.5	KUSC	Los Angeles, Calif.
91.5	WBEZ	Chicago, Ill.
91.5	WHA-FM	Madison, Wis.
91.5	WNYE	New York, N. Y.
91.5	WPTL	Providence, R. I.
91.7	KALW	San Francisco, Calif.
91.7	KOAG-FM	Stillwater, Okla.
91.7	KSDS	San Diego, Calif.
91.7	KSUI	Iowa City, Iowa
91.7	KUHF	Houston, Tex.
91.7	WIUC	Urbana, Ill.
91.7	WJUN	Philadelphia, Pa.
91.7	WLSU	Baton Rouge, La.
91.7	WTHS	Miami, Fla.
91.7	WUOA	Tuscaloosa, Ala.
91.7	WUOM	Ann Arbor, Mich.
92.1	W2XEA	Alpine, N. J.
92.1	WNAE-FM	Warren, Pa.
92.3	KFEQ-FM	St. Joseph, Mo.
92.3	KRPO	San Jose, Calif.
92.3	KVNJ-FM	Fargo, N. D.
92.3	WEBC-FM	Superior, Wis.
92.3	WCOH-FM	Newnan, Ga.
92.3	WCOL-FM	Columbus, Ohio
92.3	WJOB-FM	Hammond, Ind.
92.3	WPRO-FM	Providence, R. I.
92.5	KCMC-FM	Texarkana, Tex.
92.5	KRLD-FM	Dallas, Tex.
92.5	KYW-FM	Philadelphia, Pa.
92.5	WFRS	Grand Rapids, Mich
92.5	WGOV-FM	Valdosta, Ga.
92.5	WHAV-FM	Haverhill, Mass.
92.5	WINC-FM	Winchester, Va.
92.5	WMBD-FM	Peoria, Ill.
92.9	KBUR-FM	Burlington, Iowa
92.9	KDKA-FM	Pittsburgh, Pa.
92.9	KGDM-FM	Stockton, Calif.
92.9	KONO-FM	San Antonio, Texas
92.9	KOAD-FM	Omaha, Nebraska
92.9	WBNY-FM	Buffalo, N. Y.
92.9	WBZ-FM	Boston, Mass.
92.9	WEEU-FM	Reading, Pa.
92.9	WOSH-FM	Oshkosh, Wis.
93.1	KNX-FM	Hollywood, Calif.
93.1	KWBW-FM	Hutchinson, Kans.
93.1	WAIR-FM	Winston-Salem, N. C.
93.1	WFBL-FM	Syracuse, N. Y.
93.1	WGUY-FM	Bangor, Me.
93.1	WHYN-FM	Holyoke, Mass.
93.1	WJBK-FM	Detroit, Mich.
93.1	WKAT-FM	Miami Beach, Fla.
93.1	WKBH-FM	La Crosse, Wis.
93.3	WFLA-FM	Tampa, Fla.
93.3	WGBR-FM	Goldsboro, N. C.
93.3	WIP-FM	Philadelphia, Pa.
93.3	WJTN-FM	Jamestown, N. Y.
93.3	WKPB	Knoxville, Tenn.
93.3	WKYC	Paducah, Ky.
93.3	WRBL-FM	Columbus, Ga.
93.3	WTMJ-FM	Milwaukee, Wis.
93.5	KOCS-FM	Ontario, Calif.
93.5	WDHN	New Brunswick, N. J.
93.7	KRFM	Fresno, Calif.
93.7	KVSO-FM	Ardmore, Okla.
93.7	KXOK-FM	St. Louis, Mo.

FREQUENCY (MC)	CALL	LOCATION
93.7	WCSI	Columbus, Ind.
93.7	WCSI	Franklin, Ind.
93.7	WDRC-FM	Hartford, Conn.
93.7	WFBC-FM	Greenville, S. C.
93.7	WKJF	Pittsburgh, Pa.
93.7	WLAW-FM	Lawrence, Mass.
93.7	WSGN-FM	Birmingham, Ala.
93.9	KSPI-FM	Stillwater, Okla.
93.9	WCOU-FM	Lewiston, Me.
93.9	WNYC-FM	New York, N. Y.
93.9	WRC-FM	Washington, D. C.
93.9	WROW-FM	Albany, N. Y.
94.1	KERN-FM	Bakersfield, Calif.
94.1	KLZ-FM	Denver, Colo.
94.1	WEAU-FM	Eau Claire, Wis.
94.1	WEMP-FM	Milwaukee, Wis.
94.1	WGST-FM	Atlanta, Ga.
94.1	WHBC-FM	Canton, Ohio
94.1	WIBG-FM	Philadelphia, Pa.
94.1	WKOK-FM	Sunbury, Pa.
94.1	WMIX-FM	Mt. Vernon, Ill.
94.1	WREN-FM	Topeka, Kans.
94.3	WBEC-FM	Pittsfield, Mass.
94.3	WJLK-FM	Asbury Park, N. J.
94.3	WOCB-FM	West Yarmouth, Mass.
94.5	KGKL-FM	San Angelo, Texas
94.5	KWOC-FM	Poplar Bluff, Mo.
94.5	WHDM-FM	Boston, Mass.
94.5	WIS-FM	Columbia, S. C.
94.5	WMLL	Evansville, Ind.
94.5	WMOT-FM	Pittsburgh, Pa.
94.5	WNDB-FM	Daytona Beach, Fla.
94.5	WSYR-FM	Syracuse, N. Y.
94.7	KOCY-FM	Oklahoma City, Okla.
94.7	KROC-FM	Rochester, Minn.
94.7	WAAT-FM	Newark, N. J.
94.7	WAPO-FM	Chattanooga, Tenn.
94.7	WENR-FM	Chicago, Ill.
94.7	WMAS-FM	Springfield, Mass.
94.7	WMCP	Baltimore, Md.
94.9	KAKC-FM	Tulsa, Okla.
94.9	KCFM	Kansas City, Mo.
94.9	KFPW-FM	Fort Smith, Ark.
94.9	KING-FM	Seattle, Wash.
94.9	KSCJ-FM	Sioux City, Iowa
94.9	KSFH	San Francisco, Calif.
94.9	WCMW-FM	Canton, Ohio
94.9	WDBJ-FM	Roanoke, Va.
94.9	WMRC-FM	Greenville, S. C.
94.9	WQAM-FM	Miami, Fla.
94.9	WWCF	Greenfield, Wis.
94.9	WXLW-FM	Indianapolis, Ind.
95.1	KFXM-FM	San Bernardino, Calif.
95.1	WEW-FM	St. Louis, Mo.
95.1	WGBA-FM	Columbus, Ga.
95.1	WGPA-FM	Bethlehem, Pa.
95.1	WHBS-FM	Huntsville, Ala.
95.1	WPDX-FM	Clarksburg, W. Va.
95.1	WRXW	Louisville, Ky.
95.1	WTMA-FM	Charleston, S. C.
95.1	WTRF-FM	Bellaire, Ohio
95.1	WVFC	Ithaca, N. Y.
95.3	KGBS-FM	Harlingen, Texas
95.3	KSJO-FM	San Jose, Calif.
95.3	WSRS-FM	Cleveland Heights, Ohio
95.5	KECA-FM	Los Angeles, Calif.
95.5	KPRA	Portland, Ore.
95.5	KRBA-FM	Lufkin, Texas
95.5	WBGE-FM	Atlanta, Ga.
95.5	WCHA-FM	Chambersburg, Pa.
95.5	WHPE-FM	High Point, N. C.
95.5	WJAC-FM	Johnstown, Pa.
95.5	WJAR-FM	Providence, R. I.
95.5	WJZ-FM	New York, N. Y.
95.5	WMBI-FM	Chicago, Ill.
95.5	WPAM-FM	Pottsville, Pa.
95.5	WRWR	Albany, N. Y.
95.7	KOA-FM	Denver, Colo.
95.7	WCRS-FM	Greenwood, S. C.
95.7	WMMW-FM	Meriden, Conn.
95.7	WMUR-FM	Manchester, N. H.
95.7	WTPS-FM	New Orleans, La.
95.9	WFMZ	Allentown, Pa.
96.1	KCRA-FM	Sacramento, Calif.
96.1	KFMX	Council Bluffs, Iowa
96.1	KLCN-FM	Blytheville, Ark.
96.1	WAMS-FM	Wilmington, Del.
96.1	WBCM-FM	Bay City, Mich.
96.1	WCAE-FM	Pittsburgh, Pa.

FREQUENCY (MC)	CALL	LOCATION
96.1	WGAA-FM	Cedarstown, Ga.
96.1	WMBH-FM	Joplin, Mo.
96.1	WNAO-FM	Raleigh, N. C.
96.1	WOHS-FM	Shelby, N. C.
96.1	WOWO-FM	Ft. Wayne, Ind.
96.1	WTAG-FM	Worcester, Mass.
96.1	WVJS-FM	Owenboro, Ky.
96.3	KRED	Eureka, Calif.
96.3	KRKD-FM	Los Angeles, Calif.
96.3	WBIK	Chicago, Ill.
96.3	WINX-FM	Washington, D. C.
96.3	WJMC-FM	Rice Lake, Wis.
96.3	WJR-FM	Detroit, Mich.
96.3	WQXR-FM	New York, N. Y.
96.5	KRON	San Francisco, Calif.
96.5	KSDO	San Diego, Calif.
96.5	KSEI-FM	Pocatello, Idaho
96.5	KXYZ-FM	Houston, Texas
96.5	WAPJ	Altoona, Pa.
96.5	WGH-FM	Norfolk, Va.
96.5	WHEC-FM	Rochester, N. Y.
96.5	WHOO-FM	Orlando, Fla.
96.5	WTIC-FM	Hartford, Conn.
96.7	WBUZ	Bradbury Heights, Md.
96.7	WEAW	Evanston, Ill.
96.7	WSTC-FM	Stamford, Conn.
96.7	WVAW-FM	Cheviot, Ohio.
96.9	KALB-FM	Alexandria, La.
96.9	KCRK	Cedar Rapids, Iowa
96.9	KFBK-FM	Sacramento, Calif.
96.9	KRBC-FM	Abilene, Texas
96.9	WCSC-FM	Charleston, S. C.
96.9	WEBR-FM	Buffalo, N. Y.
96.9	WIBX-FM	Utica, N. Y.
96.9	WJHP-FM	Jacksonville, Fla.
96.9	WLAN-FM	Lancaster, Pa.
96.9	WLAV-FM	Grand Rapids, Mich.
96.9	WOPI-FM	Bristol, Tenn.
96.9	WPAD-FM	Paducah, Ky.
96.9	WXHR-FM	Cambridge, Mass.
97.1	KKLA	Los Angeles, Calif.
97.1	KMHB	Belton, Tex.
97.1	KPFM-FM	Portland, Ore.
97.1	KTUL-FM	Tulsa, Okla.
97.1	WASH	Washington, D. C.
97.1	WBBM-FM	Chicago, Ill.
97.1	WBZA-FM	Springfield, Mass.
97.1	WELD-FM	Columbus, Ohio
97.1	WMHC	Indianapolis, Ind.
97.1	WNBC-FM	New York, N. Y.
97.1	WRCM	New Orleans, La.
97.1	WTCN-FM	Minneapolis, Minn.
97.1	WWJ-FM	Detroit, Mich.
97.3	KSO-FM	Des Moines, Iowa

RADIO-CRAFT will pay full space rates for construction articles on *modern* standard and shortwave receivers. Sets should be preferably small—six tubes or less—and built with new efficient postwar tubes and components. Similar articles on other radio and electronic equipment will also be welcomed.

FREQUENCY (MC)	CALL	LOCATION
97.3	KTRN	Wichita Falls, Texas
97.3	KWBR-FM	Oakland, Calif.
97.3	KWBR-FM	San Francisco, Calif.
97.3	WFMY	Greensboro, N. C.
97.3	WHCU-FM	Ithaca, N. Y.
97.3	WHP-FM	Harrisburg, Pa.
97.3	WIL-FM	St. Louis, Mo.
97.3	WIOD-FM	Miami, Fla.
97.3	WKWK-FM	Wheeling, W. Va.
97.3	WROL-FM	Knoxville, Tenn.
97.3	WTAR-FM	Norfolk, Va.
97.3	WTOC-FM	Savannah, Ga.
97.5	KPOR	Riverside, Calif.
97.5	KWNO-FM	Winona, Minn.
97.5	WAKR-FM	Akron, Ohio
97.5	WATL-FM	Atlanta, Ga.
97.5	WBOC-FM	Salisbury, Md.
97.5	WESB-FM	Bradford, Pa.
97.5	WLVA-FM	Lynchburg, Va.
97.5	WSIX-FM	Nashville, Tenn.
97.7	WISR-FM	Butler, Pa.
97.9	KFAB-FM	Lincoln, Nebr.
97.9	WBTM-FM	Danville, Va.
97.9	WEHS	Chicago, Ill.
97.9	WFAA-FM	Dallas, Texas
97.9	WGYN-FM	New York, N. Y.
97.9	WJLB-FM	Detroit, Mich.
97.9	WLEU-FM	Erie, Pa.
97.9	WLPM-FM	Suffolk, Va.
97.9	WLTN	Lewistown, Pa.
97.9	WMAR-FM	Baltimore, Md.
97.9	WMRF-FM	Lewiston, Pa.
97.9	WRNY-FM	Rochester, N. Y.
97.9	WWPG-FM	Palm Beach, Fla.
98.1	KOZY	Kansas City, Mo.
98.1	KQV-FM	Pittsburgh, Pa.
98.1	KRSC-FM	Seattle, Wash.
98.1	WCOD-FM	Richmond, Va.
98.1	WLAU-FM	Philadelphia, Pa.
98.1	WBRL	Baton Rouge, La.
98.1	WFMR	New Bedford, Mass.
98.1	WFNC-FM	Fayetteville, N. C.
98.1	WSAL	Saginaw, Mich.
98.1	WVUN	Chattanooga, Tenn.
98.3	KAGH	Pasadena, Calif.
98.3	WEEX	Easton, Pa.
98.3	WHAI-FM	Greenfield, Mass.
98.3	WHNY-FM	Hempstead, N. Y.
98.3	WLAD-FM	Danbury, Conn.
98.3	WOAK	Oak Park, Ill.
98.3	WPIK	Alexandria, Va.
98.3	WTFM-FM	Tiffin, Ohio
98.5	KBIX-FM	Muskogee, Okla.
98.5	KBTR	Minneapolis, Minn.
98.5	KOPY	Houston, Texas
98.5	KWOS-FM	Jefferson City, Mo.
98.5	WAGE-FM	Syracuse, N. Y.
98.5	WBRE-FM	Wilkes-Barre, Pa.
98.5	WCBT-FM	Roanoke Rapids, N. C.
98.5	WHLD-FM	Niagara Falls, N. Y.
98.5	WJPF-FM	Herrin, Ill.
98.5	WKPT-FM	Kingsport, Tenn.
98.5	WMOX-FM	Meridian, Miss.
98.5	WNAM-FM	Neenah, Wis.
98.7	KDYL-FM	Salt Lake City, Utah
98.7	KMGM	Los Angeles, Calif.
98.7	KPOJ-FM	Portland, Ore.
98.7	KVWC-FM	Vernon, Texas
98.7	WCTP	Greensboro, N. C.
98.7	WGNB	Chicago, Ill.
98.7	WHKB	Columbus, Ohio
98.7	WHOP-FM	Hopkinsville, Ky.
98.7	WJNO-FM	West Palm Beach, Fla.
98.7	WPAG-FM	Ann Arbor, Mich.
98.7	WOR-FM	New York, N. Y.
98.7	WSOY-FM	Decatur, Ill.
98.7	WWVA-FM	Wheeling, W. Va.
98.9	KBOA	Kennett, Mo.
98.9	KJBS-FM	San Francisco, Calif.
98.9	WCOA-FM	Pensacola, Fla.
98.9	WHBF-FM	Rock Island, Ill.
98.9	WHFM	Rochester, N. Y.
98.9	WKBN-FM	Youngstown, Ohio
98.9	WKY-FM	Oklahoma City, Okla.
98.9	WSNJ-FM	Bridgeton, N. J.
98.9	WSPA-FM	Spartanburg, S. C.
99.1	WNHC-FM	New Haven, Conn.
99.1	KUGN-FM	Eugene, Ore.
99.1	KWK-FM	St. Louis, Mo.
99.1	WDOS-FM	Oneonta, N. Y.
99.1	WGTR	Boston, Mass.
99.1	WHIO-FM	Dayton, Ohio
99.1	WMAZ-FM	Macon, Ga.
99.1	WNAV-FM	Annapolis, Md.
99.1	WSLS-FM	Roanoke, Va.
99.1	WTTH-FM	Port Huron, Mich.
99.1	WVMH	Hillsdale, Mich.
99.3	KGAR-FM	Garden City, Kans.
99.3	WAJR-FM	Morgantown, W. Va.
99.3	WFRO-FM	Fremont, Ohio
99.5	KFYO-FM	Lubbock, Tex.
99.5	KISS	San Antonio, Tex.
99.5	KRIC-FM	Beaumont, Tex.
99.5	WABF	New York, N. Y.
99.5	WAFM-FM	Birmingham, Ala.
99.5	WEFM	Chicago, Ill.
99.5	WGFM	Schenectady, N. Y.
99.5	WJLS-FM	Beckley, W. Va.
99.5	WMFR-FM	High Point, N. C.
99.5	WMIN-FM	St. Paul, Minn.
99.5	WNLC-FM	New London, Conn.
99.5	WSON-FM	Henderson, Ky.
99.5	WTAD-FM	Quincy, Ill.
99.7	KNBC-FM	San Francisco, Calif.
99.7	KPDR-FM	Alexandria, La.
99.7	KTFI-FM	Twin Falls, Idaho
99.7	WHAS-FM	Louisville, Ky.
99.7	WJAS-FM	Pittsburgh, Pa.
99.7	WMC-FM	Memphis, Tenn.
99.7	WSAP-FM	Portsmouth, Va.
99.9	KBMT	San Bernardino, Calif.
99.9	KMYC-FM	Marysville, Calif.
99.9	KVEC-FM	San Luis Obispo, Calif.
99.9	KWFT-FM	Wichita Falls, Tex.
99.9	WBT-FM	Charlotte, N. C.
99.9	WCLO-FM	Janesville, Wis.
99.9	WEBQ-FM	Harrisburg, Ill.
99.9	WERC-FM	Erie, Pa.
99.9	WFNS-FM	Burlington, N. C.
99.9	WHFB-FM	Benton Harbor, Mich.
99.9	WKMO-FM	Kokomo, Ind.
99.9	WKRG-FM	Mobile, Ala.
99.9	WKRT-FM	Cortland, N. Y.
99.9	WSAN-FM	Allentown, Pa.
99.9	WTRT-FM	Toledo, Ohio.
100.1	WKBR-FM	Manchester, N. H.
100.1	WLBR-FM	Lebanon, Pa.
100.1	WMUS-FM	Muskegon, Mich.

FREQUENCY (MC)	CALL	LOCATION
100.3	KGW-FM	Portland, Ore.
100.3	KMPC-FM	Hollywood, Calif.
100.3	KSL-FM	Salt Lake City, Utah.
100.3	WACE-FM	Chicopee, Mass.
100.3	WCLT	Newark, Ohio.
100.3	WCNB	Connersville, Ind.
100.3	WFMF	Chicago, Ill.
100.3	WGBG-FM	Greensboro, N. C.
100.3	WHO-FM	Des Moines, Iowa
100.3	WMGM	New York, N. Y.
100.3	WRAK-FM	Williamsport, Pa.
100.3	WSAV-FM	Savannah, Ga.
100.3	WWLH	New Orleans, La.
100.5	KMBC-FM	Kansas City, Mo.
100.5	KSBR	San Bruno, Calif.
100.5	WDXY	Spartanburg, S. C.
100.5	WFIN-FM	Findlay, Ohio
100.5	WHMA-FM	Anniston, Ala.
100.5	WHTN-FM	Huntington, W. Va.
100.5	WLDS-FM	Jacksonville, Ill.
100.5	WMNE	Mt. Washington, N. H.
100.5	WMUS-FM	Muskegon, Mich.
100.5	WNBF-FM	Binghamton, N. Y.
100.5	WWNY-FM	Watertown, N. Y.
100.7	KIRO-FM	Seattle, Wash.
100.7	WBAB-FM	Atlantic City, N. J.
100.7	WBIB	New Haven, Conn.
100.7	WBML-FM	Macon, Ga.
100.7	WBOX-FM	Louisville, Ky.
100.7	WCEC-FM	Rocky Mount, N. C.
100.7	WCIL-FM	Carbondale, Ill.
100.7	WHKX	Cleveland, Ohio
100.7	WKAP-FM	Allentown, Pa.
100.7	WKIL	Kankakee, Ill.
100.7	WRJN-FM	Racine, Wis.
100.7	WSVA-FM	Harrisonburg, Va.
100.7	WTJS-FM	Jackson, Tenn.
100.7	WTRC-FM	Elkhart, Ind.
100.9	WABX-FM	Harrisburg, Pa.
100.9	WBYS-FM	Canton, Ill.
100.9	WCFR	Fall River, Mass.
101.1	KGLO-FM	Mason City, Iowa
101.1	KHJ-FM	Hollywood, Calif.
101.1	KTRH-FM	Houston, Texas
101.1	KVCI-FM	Chico, Calif.
101.1	KXLW-FM	Clayton, Mo.
101.1	WBBB-FM	Burlington, N. C.
101.1	WBCA-FM	Schenectady, N. Y.
101.1	WBOW-FM	Terre Haute, Ind.
101.1	WCAC-FM	Anderson, S. C.
101.1	WCBS-FM	New York, N. Y.
101.1	WJPG-FM	Green Bay, Wis.
101.1	WKST-FM	New Castle, Pa.
101.1	WLCS-FM	Baton Rouge, La.
101.1	WLWA-FM	Cincinnati, Ohio
101.1	WWDC-FM	Washington, D. C.
101.1	WXYZ-FM	Detroit, Mich.
101.3	KLX-FM	Oakland, Calif.
101.3	WATG-FM	Ashland, Ohio
101.3	WCFC	Beckley, W. Va.
101.3	WGAL-FM	Lancaster, Pa.
101.3	WSBF	South Bend, Ind.
101.3	WSRK	Shelbyville, Ind.
101.5	KFMB-FM	San Diego, Calif.
101.5	KGKB-FM	Tyler, Tex.
101.5	KMUS	Muskogee, Okla.
101.5	KYFM-FM	San Antonio, Tex.
101.5	WFMD-FM	Frederick, Md.
101.5	WGCM-FM	Gulfport, Miss.
101.5	WIBA-FM	Madison, Wis.
101.5	WJBC-FM	Bloomington, Ill.
101.5	WRAL-FM	Raleigh, N. C.
101.5	WSPD-FM	Toledo, Ohio
101.5	WWPB-FM	Miami, Fla.
101.7	KWIL-FM	Albany, Ore.
101.7	WFAH-FM	Alliance, Ohio
101.7	WLIN-FM	Merrill, Wis.
101.9	KARM-FM	Fresno, Calif.
109.9	KFXD-FM	Nampa, Idaho
101.9	WCTS	Cincinnati, Ohio
101.9	WGAN-FM	Portland, Me.
101.9	WGHF	New York, N. Y.
101.9	WGNC-FM	Gastonia, N. C.
101.9	WSFL	Springfield, Mass.
101.9	WSYO	Sylacauga, Ala.
101.9	WVBT	South Bristol, N. Y.

Suggested by W. J. Corbett, Springfield, Mass.
"Look Ma! We're playing television."

FREQUENCY (MC)	CALL	LOCATION
101.9	WVCV	Cherry Valley, N. Y.
102.1	KSTP-FM	St. Paul, Minn.
102.1	KRKN-FM	Fort Smith, Ark.
102.1	WELL-FM	Battle Creek, Mich.
102.1	WEWS-FM	Cleveland, Ohio
102.1	WFIL-FM	Philadelphia, Pa.
102.1	WIMA-FM	Lima, Ohio
102.1	WRNL-FM	Richmond, Va.
102.3	WGAY-FM	Silver Spring, Md.
102.5	WFJS	Freeport, Ill.
102.5	WIBW-FM	Topeka, Kans.
102.5	WNDR-FM	Syracuse, N. Y.
102.5	WISE-FM	Asheville, N. C.
102.5	WOAI-FM	San Antonio, Texas
102.5	WPLH-FM	Huntington, W. Va.
102.5	WRVC	Norfolk, Va.
102.5	WTSP-FM	St. Petersburg, Fla.
102.7	KCRC-FM	Enid, Okla.
102.7	KOKX-FM	Keokuk, Iowa
102.7	KFMY	Fort Dodge, Iowa
102.7	WCAO-FM	Baltimore, Md.
102.7	WSMB-FM	New Orleans, La.
102.7	WTRI-FM	Troy, N. Y.
102.9	KFOR-FM	Lincoln, Nebr.
102.9	KPRC-FM	Houston, Tex.
102.9	WCVS-FM	Springfield, Ill.
102.9	WFMU	Crawfordsville, Ind.
102.9	WHKY-FM	Hickory, N. C.
102.9	WJDX-FM	Jackson, Miss.
102.9	WLET	Toccoa, Ga.
102.9	WPEN-FM	Philadelphia, Pa.
102.9	WPIC-FM	Sharon, Pa.
102.9	WRLD-FM	Lanett, Ala.
103.1	KRJM	Santa Maria, Calif.
103.1	WCTW	New Castle, Ind.
103.1	WFMO-FM	Jersey City, N. J.
103.1	WJJW	Wyandotte, Mich.
103.1	WOAP-FM	Owosso, Mich.
103.1	WRGK	La Grange, Ill.
103.3	KBEE	Modesto, Calif.
103.3	WAGA-FM	Atlanta, Ga.
103.3	WDBQ	Dubuque, Iowa
103.3	WEEI-FM	Boston, Mass.
103.3	WIZZ	Wilkes-Barre, Pa.
103.3	WLOG-FM	Logan, W. Va.
103.3	WSBA-FM	York, Pa.
103.3	WSFA-FM	Montgomery, Ala.
103.3	WSM-FM	Nashville, Tenn.
103.5	KYSM-FM	Mankato, Minn.
103.5	WMOH-FM	Hamilton, Ohio
103.5	WSOC-FM	Charlotte, N. C.
103.5	WSTV-FM	Steubenville, Ohio
103.7	KOW-FM	San Francisco, Calif.
103.7	WFBG-FM	Altoona, Pa.
103.7	WJBY-FM	Gadsden, Ala.
103.7	WKNB-FM	New Britain, Conn.
103.7	WROV-FM	Roanoke, Va.
103.7	WSAR-FM	Fall River, Mass.
103.7	WTAX-FM	Springfield, Ill.
103.9	KENO-FM	Las Vegas, Nev.
103.9	KOPP-FM	Ogden, Utah
103.9	WBNU	Aurora, Ill.
103.9	WDLB-FM	Marshfield, Wis.
103.9	WFAS-FM	White Plains, N. Y.
103.9	WJEM	Springfield, Ohio
103.9	WTAL-FM	Tallahassee, Fla.
103.9	WXNJ	Green Brook Twp., N. J.
104.1	KFUO-FM	St. Louis, Mo.
104.1	KMFM	Monroe, La.
104.1	WBMS-FM	Boston, Mass.
104.1	WJW-FM	Cleveland, Ohio
104.1	WLAB	Lebanon, Pa.
104.1	WMUN	Muncie, Ind.
104.1	WPAY-FM	Portsmouth, Ohio
104.1	WRUF-FM	Gainesville, Fla.
104.1	WSJS-FM	Winston-Salem, N. C.
104.3	KGNC-FM	Amarillo, Texas
104.3	KTOK-FM	Oklahoma City, Okla.
104.3	KWLK-FM	Longview, Wash.
104.3	WAFB-FM	Baton Rouge, La.
104.3	WEXL-FM	Royal Oak, Mich.
104.3	WITH-FM	Baltimore, Md.
104.3	WLOS-FM	Asheville, N. C.
104.5	KIXL-FM	Dallas, Tex.
104.5	KRCC	Richmond, Calif.
105.5	WHIS-FM	Bluefield, W. Va.
104.5	WWST-FM	Wooster, Ohio
104.7	KWFM	San Diego, Calif.
104.7	WFIM-FM	Fitchburg, Mass.
104.7	WHVA	Poughkeepsie, N. Y.
104.7	WIST	Charlotte, N. C.
104.7	WJEJ-FM	Hagerstown, Md.
104.7	WJLD-FM	Birmingham, Ala.
104.7	WOPT-FM	Oswego, N. Y.
104.9	KONG	Alameda, Calif.
104.9	KURV-FM	Edinburg, Tex.
104.9	WLAL	Lakewood, Ohio
104.9	WMCK-FM	McKeesport, Pa.
105.1	KCLI	Los Angeles, Calif.
105.1	WDNC-FM	Durham, N. C.
105.1	WFMJ-FM	Youngstown, Ohio
105.1	WODI	Quincy, Ill.
105.1	WVCN	De Ruyter, N. Y.
105.3	WARY	Norfolk, Va.
105.3	WWHG	Hornell, N. Y.
105.5	WFOB	Fostoria, Ohio
105.7	KIMV	Hutchinson, Kans.
105.7	KUOA-FM	Siloam Springs, Ark.
105.7	KXEL-FM	Waterloo, Iowa
105.7	WARM-FM	Scranton, Pa.
105.7	WDAE-FM	Tampa, Fla.
105.7	WMBS-FM	Uniontown, Pa.
105.7	WRUN-FM	Rome, N. Y.
105.7	WSIC-FM	Statesville, N. C.
105.9	KFI-FM	Los Angeles, Calif.

FREQUENCY (MC)	CALL	LOCATION
105.9	KOMA-FM	Oklahoma City, Okla.
105.9	KSBS	Kansas City, Kans.
106.1	KDNT-FM	Denton, Tex.
106.1	KGO-FM	San Francisco, Calif.
106.1	KIDO-FM	Boise, Idaho
106.1	WKJG-FM	Ft. Wayne, Ind.
106.1	WKNP-FM	Corning, N. Y.
106.1	WLOB-FM	Claremont, N. H.
106.1	WTHT-FM	Hartford, Conn.
106.3	WMLN	Mt. Clemens, Mich.
106.3	WOTW-FM	Nashua, N. H.
106.5	WBEN-FM	Buffalo, N. Y.
106.5	WFML	Washington, Ind.
106.5	WGOR	Ft. Lauderdale, Fla.
106.5	WRGA-FM	Rome, Ga.
106.5	WSTP-FM	Salisbury, N. C.
106.7	WCLC	Clarksville, Tenn.
106.7	WGTM-FM	Wilson, N. C.
106.9	WHHM-FM	Memphis, Tenn.
106.9	WMIT	Winston-Salem, N. C.
107.1	WAJL	Flint, Mich.
107.1	WCAP-FM	Asbury Park, N. J.
107.1	WLEY	Elmwood Park, Ill.
107.1	WWDX-FM	Paterson, N. J.
107.3	KSEO-FM	Durant, Okla.
107.3	WBNB	Beloit, Wis.
107.3	WFMI	Portsmouth, N. H.
107.3	WMAL-FM	Washington, D. C.
107.5	KTEM-FM	Temple, Texas
107.7	KFSA	Fort Smith, Ark.
107.7	WAYS-FM	Charlotte, N. C.
107.9	KXOA-FM	Sacramento, Calif.
107.9	WABB	Mobile, Ala.
107.9	WDAK-FM	Columbus, Ga.
107.9	WEMI	New Haven, Conn.
107.7	WFNF	Wethersfield, N. Y.
107.7	WLIV	Providence, R. I.
107.7	WVBN	Turin, N. Y.
107.9	WEST-FM	Bethlehem, Pa.
107.9	WRRN-FM	Warren, Ohio
107.9	WWOD-FM	Lynchburg, Va.

The stations are listed this month by frequency and the list was checked against the latest information available. We'll have another list for you, probably in December, giving the latest information. This month's list gives 121 stations more than our June list, indicating the rapid growth of FM.

Book Reviews

TECHNIQUE OF MICROWAVE MEASUREMENTS (Volume XI of the M.I.T. Radiation Laboratory Series), edited by Carol G. Montgomery. Published by McGraw-Hill Book Co., Inc. 6¼ x 9¼ inches, 939 pages. Price $10.

Like the other volumes of the MIT Radiation Laboratory series, Volume XI is a compilation, written by several authors, of knowledge gained during the war in many laboratories.

There are four main measurement techniques covered by the book. These are power, frequency and wavelength, impedance and standing waves, and attenuation and radiation. Each technique differs radically from its counterpart in low-frequency work. Not only must standard procedures be revised, but many new factors must be taken into account. The dielectric constants of all the media and materials concerned must be accurately known, for example, and such properties as the capacitance and inductance of the shortest wire connections assume great importance. Electron transit time makes normal tubes useless in microwave work and special klystrons have been developed.

This volume is a comprehensive and authoritative compilation of all the available information on microwave measurement. But in describing measurements, a good deal of information on the basic methods of generation, propagation, and reception is given. The calculation of waveguide dimensions and the conformation of the guides is treated in great detail, as are many other subjects, such as klystrons, oscillators, and attenuators.—*R.H.D.*

TELEVISION—HOW IT WORKS, by Wm. Bouie, S. D. Uslan, H. Chanes and R. F. Koch. Published by John F. Rider Publisher, Inc. Paper covers, 8½ x 11 inches, 203 pages. Price $2.70.

The works of four authors have been combined in this latest edition to the Rider's "How it Works" series. These authors present television theory so it is easily understood by anyone with a knowledge of basic radio.

There are 12 chapters covering television systems, television signals, antennas, r.f. circuits, audio and video channels, sync and sweep circuits, picture tubes, power supplies, and TV receiver servicing. The book is well illustrated with drawings and partial schematics showing various types of circuits found in the more common TV receivers. —*RFS.*

TELEVISION AND FM RECEIVER SERVICING, by Milton S. Kiver. Published by D. Van Nostrand Co., Inc. Paper covers, 8½ x 11 inches, 212 pages. Price $2.95.

This is a practical treatment of television and FM receiver servicing theory and practice prepared by the author of *Television Simplified* and *FM Simplified.* The first chapter covers v.h.f. antenna systems, their characteristics and installation methods. Design data is given on several types of FM and TV antennas and a number of commercial systems are illustrated and described. The next eight chapters are devoted entirely to television receiver servicing. Equipment required for servicing is described and illustrated with block diagrams and simplified schematics. Pictures of test patterns show the effects

of various types of interference and maladjustment within the set.

The last four chapters cover FM fundamentals, typical commercial FM receiver circuits, and aligning and servicing FM receivers.

This book will prove useful to TV and FM service technicians, particularly when manufacturer's servicing data is not available.—*R.F.S.*

ELEMENTARY INDUSTRIAL ELECTRONICS, by William R. Wellman. Published by D. Van Nostrand Co., Inc. 6¼ x 9¼ inches, 372 pages. Price $3.20.

Those persons interested in electronic tubes and their industrial applications, will find this book informative and easy to read. It has been prepared for students, maintenance engineers and workers in allied fields who desire a basic knowledge of electronics.

Among the devices and theories described are: a.c. fundamentals, basic principles of vacuum tubes, gas-filled tubes, industrial applications of kenotrons, applications of hot-cathode gas-type rectifiers, mercury-pool rectifiers, vacuum-tube amplifiers, industrial high frequency heating, electronic control of motors and generators, electronic control of resistance welding, photoelectric devices, and electronic lamps.

The reader will appreciate the carefully worded descriptions of the actions occuring in various types of tubes, together with the clear diagrams. A chapter is devoted to electronic symbols and terms, suitably illustrated. The section on kenotrons and hot-cathode gas-filled rectifiers includes diagrams of thyratron battery chargers and a thyraton inverter. All types of v.t. amplifiers are described, with circuit diagrams. The growing use of high frequency heating for industrial purposes makes this section particularly useful.

The chapter on electronic lamps covers many details scarcely ever mentioned in the average book on electronics. Different types of electronic lamps discussed are glow lamps of the argon and neon types, neon lighting tubes, sodium vapor lamps, high-intensity mercury vapor lamps, fluorescent lamps and their characteristics, and the high-intensity photoflash lamp. A series of questions and references are given at the end of each chapter. A suitable index completes the work.—*H.W.S.*

RADAR, What Radar Is and How It Works (Revised Edition), by Orrin E. Dunlap, Jr. Published by Harper & Brothers. 5½ x 8¼ inches, 268 pages. Price $3.00.

This is a book for the layman who has no technical background but still would like to know how radar works.

The author writes in a clear and interesting style and begins with the early inventions that led to the final development of radar as we know it today. Photos of radar apparatus and the inventors who helped to perfect it are included in the work. Many of the amazing feats performed by radar during the war are described. The later chapters deal with post-war applications of radar, the development of Teleran, Shoran, G.C.A. radar, and other systems.

The simple method of sending out pulses of radio energy and measuring the time required for the echo to be received when the wave is reflected by a ship, plane or other object, is clearly explained. If you have not kept up to date on the many applications and improved forms of radar, this book will acquaint you with them.—*H.W.S.*

RADIO SCHOOL DIRECTORY

THE TABLE OF CONTENTS

Dear Editor:

The Table of Contents in RADIO-CRAFT is almost invariably on page 10. That is inconvenient for the newsstand buyer, who may want to see what's in the magazine before he buys it. It's also a nuisance to the owner of back issues when he tries to find an article and has to thumb through 9 pages of advertising before finding the contents page.

How about putting the Table of Contents on page 2? That will save much wear and tear on the fingertips and the temper!

NATE SILVERMAN,
Los Angeles, Calif.

(Turn to the second page of this issue and take a look. You'll find the Table of Contents there! Mechanical printing difficulties have long prevented our putting it on the second page but from this month on, readers will be able to find out what's in RADIO-CRAFT without any trouble.—*Editor)*

MORE SERVICE ARTICLES

Dear Editor:

I have followed RADIO-CRAFT for about as long as it has been published. I enjoy the April Fool stories such as Fips' *Tubeless Homo-Heteradio* (RADIO-CRAFT, April, 1948) as well as the technical items.

There has been a lot of talk about a paper shortage which is forcing magazines to limit their size. In common, I think, with most readers. I approve of light material like the Fips article occasionally, but my interest in radio makes me wish that instead of printing letters from readers who try to tell taller and taller stories, you would use the space for radio articles.

I think, too, that you give too much space in the *Technotes* department to reports on very familiar troubles and very rare cases that are not likely to happen again. I would like to see that space used for more good articles on modern servicing methods.

ROBERT F. STONES,
Daytona Beach, Fla.

BEST CRYSTAL CIRCUIT

Dear Editor:

Spain, in the December, 1946, RADIO-CRAFT, gave crystal enthusiasts about as good a receiver as can be put together without using expensive parts. After I tried it for three months in competition with the *"Loud" Crystal Radio* (RADIO-CRAFT, September, 1945) and the *Modern Midget Set* (RADIO-CRAFT, January, 1948) I give it my medal for superiority.

All the sets were compared using the same components except for the capacitors. The coils were carefully trimmed for best results.

By the way, I am using the same galenas as when I started making crystal receivers in 1920!

G. S. ROBERTSON,
Montreal, Canada

RADIO-CRAFT needs more photos of service shops and service benches. We will pay $6.00 for each 6x8- or 8x10-inch glossy photo accepted. Do not "dress up" your bench, but take a bona-fide photo, preferably with men working.

OPPORTUNITY AD-LETS

Advertisements in this section cost 25c a word for each insertion. Name, address and initials must be included at the above rate. Cash should accompany all classified advertisements unless placed by an accredited advertising agency. No advertisement for less than ten words accepted. Ten percent discount six issues, twenty percent for twelve issues. Objectionable or misleading advertisements not accepted. Advertisements for October, 1948, issue must reach us not later than August 24, 1948.
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SELECTED GROUP OF MEN. GRADUATES OF WELL-known trade school, desire employment in Radio Field. Will travel anywhere. Qualified in radio servicing, installation, test instruments, circuit operation, etc. Contact Placement Dept., Eastern Technical School, 888 Purchase Street, New Bedford, Mass.

MAGAZINES (BACK DATED)—FOREIGN, DOMESTIC, arts. Books, booklets, subscriptions, pin-ups, etc. Catalog 10c (refunded). Cicerone's, 863 First Ave., New York 17, N. Y.

YOU CAN ACCURATELY ALIGN SUPERHETERODYNE receivers without signal generator. Complete instructions $1. Moneyback guarantee. Chas. Gates, Pecos 2, Texas.

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AMATEUR RADIO LICENSES. COMPLETE THEORY preparation for passing amateur radio examinations. Home study and resident courses. American Radio Institute, 101 West 63rd St., New York City. See our ad on Page 96.

NEW CARTONED RADIO TUBES 39c. WRITE FOR bargain catalog. Henshaw Radio, 3313 Delavan, Kansas City, Kansas.

WE REPAIR ALL TYPES OF ELECTRICAL INSTRUments, tube checkers and analyzers. Hazelton Instrument Co. (Electric Meter Laboratory), 140 Liberty Street, New York, N. Y. Telephone—BArclay 7-4239.

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SUITCASE SIZE RADIO SHOP-BUILD IT AND reap huge profits. Free literature, Write; Grand Federal, 3516 Woodend, Kansas City 3, Kansas.

Index To Advertisers

RADIO SCHOOL DIRECTORY
(Pages 96-97)

ONE Button—

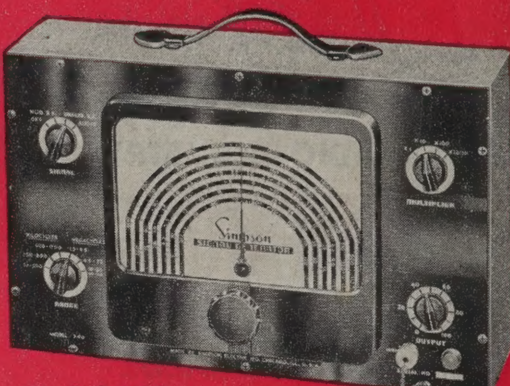
... clears every switch setting
... ready for the next tube test

Model 335 Plate Conductance Tube Tester

The Simpson Automatic Reset is just another of the practical refinements that make Simpson tube testers serve you better than other testers. When you finish a test, just press the Automatic Reset button and instantly all switches, both push button and rotary, return to normal. This not only saves time but prevents error due to previous settings being left in position at the beginning of the new test. The Reset mechanism, in whose design and tooling many thousands of dollars have been invested, is Simpson patented. No other switch control mechanism is so completely automatic.

Simpson Model 335 adds the Automatic Reset to its many other features. It tests tubes in percentages of rated plate conductance, also indicating that the tube is good, fair, doubtful, or definitely bad. Only a few settings are necessary for the most complicated tube. Sockets for all types of tubes are provided, including the new 9-pin miniature; also the sub-miniature as used in hearing aids, etc.

For 105-130 volts, 50-60 cycle. Size: 15½" x 9½" x 6¼"
Dealer's Net Price, complete with 12-page Operator's Manual $98.50



Model 340
SIGNAL GENERATOR—
75 Kilocycles to 120 Megacycles
Fundamentals to 30 MC.

Electron coupled circuit assures extreme stability and output uniformity, throughout the band. Standard 30% modulation at 400 cycles. Coil, attenuator and signal selector individually shielded. Effective shielding throughout. Each coil individually calibrated to close tolerances against crystal standards by means of variable inductance and variable minimum capacitance. For 105-130 volts, 50-60 cycle. Size: 16" x 10" x 6".

Dealer's Net Price, complete with 44-page Operator's Manual $69.85

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